

EDITORIAL

Emergence of R&D World Links for Decentralized Facilities and International Cooperation

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ABSTRACT

The United Nations Sustainable Development Goals (UNSDGs) and the European Green Deal (EGD) are two examples of global sustainability initiatives that trust strongly on research and development (R&D) activities to achieve their targets. This article explores the synergies between R&D world links and decentralised labs, highlighting their capacity to foster sustainable innovations through international collaborations and the exchange of ideas. Climate efficient materials research is key element of sustainable ambition and distributed facilities offer a better chance of leading circular technology for green world. The participation from developed and developing countries in clean R&D are needed to be promoted through multi folds cooperation. The worldwide industrial R&D utilizes cluster research collaboration which should be focused on net-zero innovation for raising product technology readiness levels (TRLs). In addition, advancements in the green know-hows are helpful in deciding the direction of technology development and transition for climate neutral infrastructures.

INTRODUCTION

Global sustainability efforts, such as the United Nations Sustainable Development Goals (UNSDGs) and the European Green Deal (EGD), rely heavily on research and development (R&D) activities [1,2]. This article provides an overview of the International Association of Advanced Materials (IAAM)' networking-based R&D upgrade to the global stage. IAAM focuses on the information and communication flows that play a part in this relationship. R&D focus on the advancement of materials to sustainability is the best strategy to achieve sustainability [3]. Recently there has been an increase in the number of inter-organizational research links and ventures, the use of computer-communication networks, and the globalization of R&D, among other developments. Recent developments in R&D, however, have been argued to be upsetting the delicate balance between the role of organizations and locations in the research process [4].

The convergence of R&D world links and decentralized facilities has opened new channels for advancing the cause of sustainable development. This occurs at a time when the global community is working hard to tackle problems like climate change, environmental protection, and equitable development. IAAM's goal with

these platforms is to spark conversations about the latest developments in materials science, which could make a big difference in achieving the UNSDGs and EGD. This article delves into how R&D world links and decentralized facilities can work together for mutual benefit, highlighting their ability to promote long-term innovation through teamwork and the sharing of knowledge. It is speculated that in 2023 and beyond, these changes will have a major effect on the structure and location of corporate R&D activities. The vast potential of these platforms in fostering revolutionary breakthroughs for a more sustainable future is the focus of our analysis of successful case studies and solutions to difficulties.

Advances in state-of-the-art technology

R&D results in new products and services creates production and application methods, and tests them for efficacy and safety. Research and development are the innovative activities undertaken by corporations, organisations, and educational institutions of private or governments to develop new products and services and improve existing ones [5]. R&D based on worldwide coverage is responsible for a substantial contribution to the world's total industrial development and brings climate neutral perspective (Fig. 1).



Fig. 1. Worldwide coverage can contribute to the industrial development in research and technology and bring sustainability.

Research and development share of substantial Gross Domestic Product (GDP) for R&D in the public, private and government organisations to develop new methods and applications. EU industrial innovation commitments determine the region's competitiveness. COVID-19 recovery, the twin green-digital transition, and the global sustainability agenda have elevated its importance.

The Nordes team's involvement in subsequent R&D projects increases the offer of innovative devices that meet our partners' and customers' needs. Expert teams and cutting-edge technology grow research and department. This work improves service and customer satisfaction. Several pillars support R&D including curiosity for the issues, networking and cooperation and reliability.

Synergies between R&D World Links and decentralized facilities

Collaboration and innovation between R&D World Links and decentralized systems may shape a sustainable future. These two interconnected platforms create a dynamic environment for solving the UNSDGs and EGD's worldwide concerns. Synergies improve collaboration and knowledge sharing. R&D World Links unites researchers, specialists, and institutions worldwide [6,7]. This helps solve difficult sustainability issues that require interdisciplinary approaches by combining multiple viewpoints, experiences, and best practices. Decentralized facilities provide local innovation centres, enabling communities to contribute to sustainable development in ways that fit their needs and environments. Researchers and entrepreneurs can access a broad skill pool and knowledge base by using both platforms. Sharing ideas and experiences fosters a global collaborative culture by cross-fertilizing new solutions and spreading successful practices. R&D world links and decentralized facilities improve financing and resource access. Due to their dedication to global sustainability, governments,

businesses, and non-profits invest in these platforms. Pooling resources lets ambitious ideas and sustainable efforts scale up. This symbiotic relationship exponentially increases technological and systemic innovation. Using artificial intelligence (AI), blockchain, and renewable energy solutions in R&D World Links and decentralized facilities advances sustainable practices [8].

FRAMING INTERNATIONAL R&D COOPERATION

Discovering current and forthcoming funding opportunities for research, as well as potential research partners, jobs, and fellowships through European Union research and innovation system facilitates research development more [9]. Gain an understanding of research initiatives and their outcomes, collaborative research projects, and EU initiatives to foster innovation.

The ability to fund projects is a key feature which involves -

- Partners, networking.
- Law and administrative regulations.
- Investigate in each field.
- Research and development policy and strategy.
- Knowledge, including books, databases, and other resources.
- News and Events.

European Union Region

European Union (EU) based companies are responsible for twenty percent of the world's total industrial investment in research and development. During the past decade, when total industrial R&D investment around the world increased by 68%, the EU has maintained its position as the second-best region in the world for investment from the private sector in research and development [10]. IAAM was the

organization that initially developed the empirical and theoretical underpinnings of this R&D [11]. To continue, this is a policy review regarding networking within the organization. Thirdly, it offers a space for several recently completed projects to be displayed. These analyses can shed light on policy patterns as well as research foci that need to be addressed.

European cluster collaboration platform

European Cluster Collaboration Platform (ECCP) is Cluster organisations for stakeholders and considered as European online hub for cluster stakeholders (organizations, policymakers, and their ecosystem) and the reference third-country stakeholders seeking partnerships with European counterparts for a better future [12]. Collaboration strengthens Europe's economy. Organisations aim to boost Europe's economy and industry, particularly SMEs, by improving productivity, innovation, internationalization, and resource efficiency. Clusters are regional ecosystems of related industries and competences with many inter-industry interdependencies. Cluster organizations are legal entities that support innovation cluster cooperation, networking, and knowledge by delivering adapted business facilities to enhance novelty, especially in SMEs. They usually enable strategic cluster partnering.

The services of the ECCP include:

- Largest information hub via ECCP newsletter.
- Webinars, capacity-building seminars, and conferences matchmaking events to promote cluster cooperation in Europe and beyond.
- Knowledge and information of database mapping for regional to international, networks, and publications developed by the ECCP, European Commission, academia, and bigger society.
- Sharing and funding networks
- Cluster organizations can find partners and use Cluster Xchange to privately exchange offer and demand.
- International cooperation pages with strategic country profiles and technical assistance (Small and Medium-sized Enterprises Go International).
- European Commission policy updates on the green world and digitalization, social economy resilience, and industrial ecosystems for a better future.
- Cluster policies are political commitments to strengthen existing clusters and encourage new ones.

Globalization and evolution of industrial R&D

Technology-based firms must constantly amend their R&Ds due to globalization, regionalization of scientific expertise, and rapid technological alteration. Technology companies' knowledge creation processes are globalizing but still limited to a few countries. Thirty-three

multinational businesses were categorized into five R&D organizational types of Multinational Corporations (MNCs), R&D hub, integrated R&D networks, ethnocentric centralized, geocentric centralized, and polycentric decentralized organizations are included. The distribution of R&D activity and unit cooperation determined the classification [13]. Many centralized R&D companies are internationalizing. They realized their R&D processes must better meet international market needs.

Developing countries

Research and development that is conducted internationally can help developing countries by improving their domestic Scientific and Technological (S&T) capacities. Accordingly, S&T competitiveness by fortifying domestic inventive capacities [14].

DECENTRALIZATION FOR SUSTAINABILITY ATTAINMENT

IAAM R&D World Links and decentralized network facilities are committed to supporting innovative research projects and facilitating collaboration. Our ultimate objective is to provide a forum where top researchers from all areas of science may meet, share ideas, and collaborate to make substantial strides in Translational Research and Innovations through the R&D World Links platform to achieve UNSDG and EGD [15]. IAAM is the central coordinator for many groups working towards a more sustainable future, including consortia, expert groups, and translational research projects. Our method prioritizes teamwork to guarantee that every aspect of a project receives input from all relevant parties. Through our extensive connections in the academic, research, and corporate communities around the world, we actively encourage research and innovation programs. **Fig. 2** illustrates the operational model of IAAM R&D World Links decentralized network facilities. It's a great example of how IAAM R&D World Links work to foster ground-breaking scientific endeavors and cooperative ventures.

Opportunities and challenges

In the context of UNSDGs and EGD, R&D World Links and decentralized facilities present a wide range of opportunities and challenges [16,17]. One beneficial aspect of these platforms is that they let researchers and specialists from all over the world work together better, share their findings, and learn from each other's viewpoints. They connect people all over the world, giving them access to an enormous pool of talent and allowing them to establish formidable teams to tackle tough problems like climate change and environmental preservation. In addition, they inspire innovation and research that serves the UNSDGs and the EGD through their emphasis on sustainability.

IAAM's roles in addressing global issues through networking and stakeholders are well recognized worldwide [18]. The key to successful cross-cultural and cross-time zone collaboration is clear and consistent communication and coordination. R&D World Links and decentralized facilities foster cross-disciplinary interactions that accelerate the development of innovative solutions to achieve affordable and clean energy, climate action, environmental conservation, responsible consumption, and

production [19]. Protecting your intellectual property and making sure your initiative has the resources it needs to make an effect are both very important factors to think about. Protecting precious intellectual property while it is transferred across international borders necessitates the use of data security and privacy protections. These platforms prioritize sustainability to help the Green Deal reduce greenhouse gas emissions, switch to renewable energy, and promote circular economies.

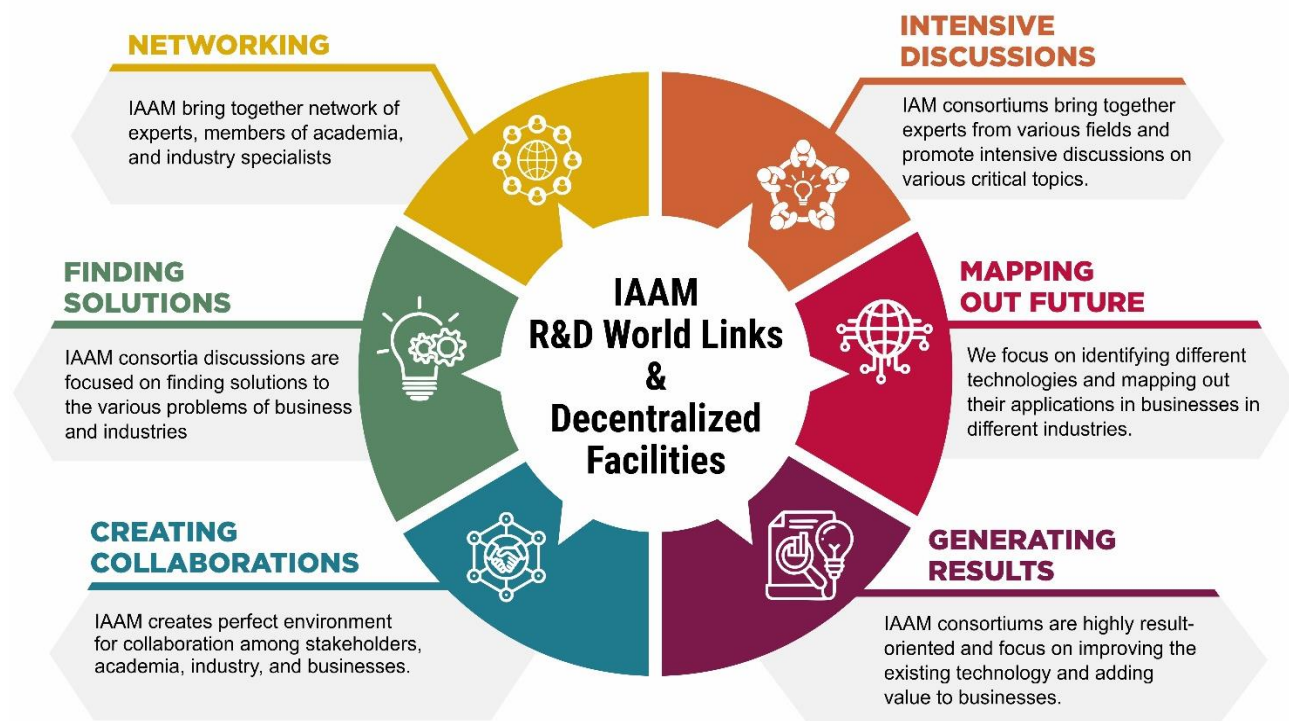


Fig. 2. IAAM Model of R&D World Links and decentralized network facilities [4].

New horizons for R&D decentralized facilities

Market-oriented R&D, which adapts products to local markets, was linked to the basic companies with production facilities located in a relatively distributed area.

R&D ORGANISATIONS

Since 1999, Research and Technology Organizations (RTOs) in Europe have been promoted by the European Association of Research and Technology Organizations (EARTO) [20]. RTOs are non-profit organizations that produce, combine, and bridge knowledge, skills, and infrastructure to conduct research and development with public and industrial partners of all sizes. These activities aim to produce technological and social innovations and system solutions that strengthen their economic, social, and policy impacts. There are currently 350 RTOs operating in, 32 distinct countries, which represent approximately 150,000 scientists, engineers, and various types of

technicians involved in collaborations with one hundred thousand companies on an annual basis.

EU countries to fund microelectronics R&D

The European Commissions approved a second microelectronics Important Project of Common European Interest (IPCEI) to make the EU greener, digital, secure, resilient, and sovereign. The European state aid assessment will allow EU Member States to invest up to €8.1 billion in research, innovation, and the first widespread use in industry of microelectronics and telecommunication, materials, chip designs and manufacturing activities [21]. 56 companies—SMEs and startups—will complete 68 IPCEI projects. Austria, the Czech Republic, Finland, France, Germany, Greece, Ireland, Italy, Malta, the Netherlands, Poland, Romania, Slovakia, and Spain are only some of the Member States that worked on the IPCEI ME/CT project and gave notice of it.

European R&D centers of Ericsson

Ericsson has helped Europe innovate since 1876. Ericsson drives the region's digital agenda with 5G, the Internet of Things, cloud, and more. Ericsson is ready for Europe's future [22]. Ericsson has 21 research and development centers located across Europe, and in each one of those centers, the company works in collaboration with the region's various industries and innovators to put European business in the driver's seat of what comes next. They represent themselves as the number one mobile communication provider in Europe and have more than one hundred different R&D collaborations in Europe. European R&D centers have 60,000 employees and organisation holds 35,000 patents.

Research and development budgets over the past decade were analyzed by way of a comparison study. The Eurostat database was mined for information to conduct this analysis covering all 28 EU member states [23]. The structure of research and development expenditure, including a breakdown by the four organisational fields: business organization, government, education, and non-profit organizations to better understand the dynamics. Business spends the most on R&D in most EU countries.

European R&D centers and green deal

The European Commission Industrial R&D Investment Scoreboard 2021 is a major global private sector R&D investment research. Huawei performs most worldwide research in Europe and supports the European Green Deal because international research collaboration boosts EU competitiveness and mitigates climate change [24]. Huawei is world's second-highest private sector investor in R&D. Huawei opened its first Swedish research center in 2000 and employs 2,400 researchers in 23 European research centers. Huawei's collaborative research modernizes Europe through deeply embedded in Europe's ICT research ecosystem via over 150 university partnerships.

United Kingdom R&D participation for net zero

The United Kingdom (UK) and EU negotiated a deal in December 2020 to allow the UK to participate in Horizon Europe, Copernicus, Euratom Research & Training, and Fusion for Energy under the Trade and Cooperation Agreement. This alliance helps British and European researchers and producers address major social issues [25]. United Kingdom will switch to a new research and development program if it is unable to participate in Horizon Europe, Copernicus, or Euratom, Net zero, pandemic preparedness, and security require research and innovation.

Recognitions for Excellence

EARTO hosts several events each year to promote networking and raise the RTO sector's profile [26]. All EARTO members can enter the annual Innovation Awards.

It honors EARTO members who contributed to innovations with significant social and economic impact. IAAM Awards and innovation- in materials, engineering, and science [27]. An independent jury chooses winners. In October, politicians and stakeholders gather in Brussels to present the prizes. IAAM embarks on this path, it hopes to encourage cooperation, spark creativity, and honor outstanding contributions to the development of eco-friendly materials. The IAAM is quite pleased with its award program because it has been honoring technological advances in materials for more than ten years. IAAM bestows titles like "Laureate," "Fellow," "Medal," and "Scientist" upon these scientists and engineers to recognize their contributions to modern materials research. This award is in recognition of their steadfast commitment, pioneering efforts, and environmental impact and advocacy. Nominations can be submitted from anywhere in the world, and the winners will be honored at next year's IAAM Annual Conference for their achievements. Innovators in the field of materials science are singled out for special recognition with both the Materials Sustainability Award and the Innovation Award. Sustainability and the lasting impact of materials are at the heart of IAAM's efforts to build a global network dedicated to materials excellence. IAAM's goal is to encourage R&D collaborations and partnerships through its membership of over 80,000 people from about 140 countries [28].

R&D global forum for materials innovation

Sustainability studies can benefit from the fine-grained control over matter that advanced materials provide. Goal No. 9 focuses on the development of productive industries and supporting infrastructure. Consortia and the IAAM Council give researchers, scientists, and business executives a place to meet, share ideas, and work together to create ground-breaking new technologies [3,29]. Sustainable elucidations that are energy efficient with cleaner production, and improve the delivery of applications in healthcare, energy, and the environment may be made possible by nanomaterials, nanodevices, and nanosystems.

When it comes to bringing together the scientific communities of academia and industry, few venues can match the prestige of the Advanced Materials Congress (AMC) [30]. In the ten years since its founding, the Advanced Materials Congress has worked to establish a global forum that brings together experts from all over the world to work toward the shared goal of advancing materials for a sustainable and greener world in the year 2030. As of the August 2023 AMC assemblies, IAAM had presided over 55 such gatherings. The annual Innovation Awards are open to all IAAM members. In a ceremony held annually on a different continent (Europe, Americas, Asia, and Australia), it awards prizes to members who have made significant contributions to innovations that have had social and economic impacts [28,30]. **Fig. 3** shows how the health,

energy, and environment sectors were prioritized during the IAAM recognitions for excellence [28].

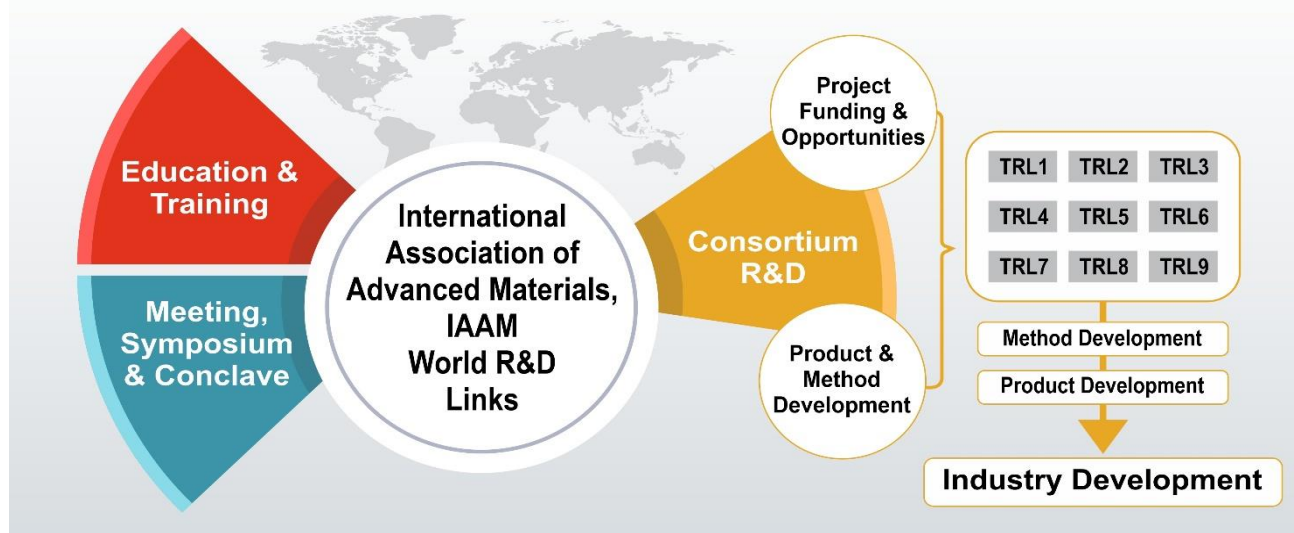


Fig. 3. IAAM recognitions focus on advancement of materials to the global excellence in the R&D for innovation, engineering, and technology [28,30].

Technology readiness levels

Technology readiness levels are primarily used to aid management in making technological development and transition decisions. It is just one of several instruments that are essential for monitoring R&D activity within a company. During the attainment phase of a program, TRLs can be used to estimate the level of development of various technologies [31]. Technology Readiness Levels (TRLs) allow for standardized, cross-discipline conversations about technologies' relative levels of development. On the TRL scale, 9 represents the most advanced technology. The EARTO has produced a widely used methodology and discussion of TRLs [26]. The Institute of Advanced Materials (IAM) places a premium on seeing that cutting-edge technologies are widely adopted so that they can be commercialized and used to their full potential. IAM provides support for commercialization efforts by businesses and groups of all sizes. IAM help with the next steps, from coming up with the idea to bringing the finished product to market [32]. In keeping with our commitment to sustainability, we provide training and educational opportunities centered on sustainable practices and principles [33]. Policymakers, professionals, young researchers, students, and industry experts are the target audience for our programs. IAM recognizes the importance of educating and inspiring professionals to work toward a more sustainable future.

WORLD R&D LINK FOR HEALTH, ENERGY AND CLIMATE

R&D connectivity for energy

Climate diplomacy to achieve global eco-neutrality and energy technology transformation to achieve climate neutrality goals [34,35]. The development of non-renewable resources such as wind and solar power technologies is regarded as one of many critical explanations for meeting the world's increasing demand for energy [36]. Using non-renewable resources as an alternative measure is the best way to reduce reliance on fossil fuels, and solar light-based technologies have enormous potential to transform industries [36,37]. The best way to transform the energy field is to use waste for climate neutral energy production [38]. Advanced technologies and metal-organic frameworks are now extremely useful in the energy sector for energy devices [39].

Hydrogen is currently driving the green energy future. Hydrogen energy research is a rapidly developing field with the potential to help the world reach its zero-carbon goals [40,41].

R&D connectivity for healthcare

The development devices based on microfluidics, as well as advancements in organ-on-a-chip materials, is beneficial to public healthcare [42,43]. The pharmaceutical sector is under stress from several external factors, such as declining profits because of patent expirations, rising healthcare costs, and tighter regulations. Research and development funds should be directed on improving proof-of-concept through novel drug discoveries and clinical signatures, target selections, etc. [44].

Digital devices are effective for the patient care around the world. Sensors continuously monitor patient systems for speedy diagnosis and intervention. Today, 3D printers, robotics, and drones being studied for precision surgery, rehabilitation, targeted drug distribution, medical logistics, etc. The IoT able to transform communication with remotely and provide strength to public healthcare [45]. Paper-based analytical device advancements for climate neutral biosensing [46]. Understanding Materials and convergence technologies, Artificial Intelligence, innovation, and their impacts, which can scale Clinical Healthcare with enormous potential is adoptable [47-51]. Modern therapeutic approaches and technologies developing healthier healthcare management models [52,53].

Environmental R&D cooperation

To tackle sustainability issues, businesses increasingly need to collaborate with their partners. Cooperation in environmental R&D can have many positive effects, but its benefits may be curtailed by the complexity of its management [54]. The various sourcing techniques used in environmental R&D cooperation can have far-reaching implications, and network connections can help to ensure their success. Today's era of sustainability is focused on new perspectives, rational designs, engineering of materials and assessment of bioproducts for eco-functionality [55,56]. Advanced Materials and technologies work for carbon neutrality achievement has time-bound targets [57]. Prioritizing R&D efforts toward climate neutrality is essential [58,59]. An important perspective on the challenges and opportunities for climate should be developed based on experimental and theoretical predictions. The IAAM R&D network is largely focused on

the positive impact of cooperation. This editorial, represents the effectiveness of health, energy, and environmental R&D cooperation to understand and move towards technology transition and create sustainable environment according to UN and IAAM agenda.

IMPLICATION OF NETWORK R&D FOR MATERIALS

Advanced materials technologies will lead to more integrated advanced-materials coordination through customized R&D and innovation, which will be beneficial to international business. The Decade's Journey to Advancing Materials examines a broad transformation of advanced materials technologies [60,61]. Most companies today run in a networked setting so that they can test out new ways of sharing and integrating data with their peers and ecosystem partners [61].

The gold thread that connects global businesses, consumers, and other stakeholders is digital connectivity. Connectivity technologies (such as AI, blockchain, cloud, stream, Geographic Information Systems, IoT, and data analytics) are critical for more efficient material progress [62,63]. With networking, the IAAM facilitates international R&D efforts to improve research and development on a global scale.

Advanced materials translational research has a positive impact on health, energy, and the environment, as shown in **Table 1** of the IAAM R&D world link. This cooperation and collaboration will likely have far-reaching effects on how and where businesses conduct their R&D. The role of the IAAM as a connecting link for unlimited organizations created opportunities for collaboration among researchers all over the world.

Table 1. R&D world link focused on innovation and technology perspective in health, energy, and environment fields through advanced materials translational research.

R&D Connectivity	Key Area	No. of Researchers	R&D Organisations	Reference
Energy	Solar light induced quantum dots	9	5	[37]
	Biomass for climate neutral energy production	7	3	[38]
	Metal-organic frameworks for supercapacitors	13	8	[39]
Health	Next generation biomedical devices	8	6	[42]
	Devices for climate neutral biosensing	7	4	[46]
	Nanohybrid-based immunosensor	6	6	[47]
	Sustainable chemical preventive models	16	14	[49]
	Scenario of Pandemic	12	8	[51]
	State-of-the-art therapeutic strategies	12	10	[52]
	Sustainable healthcare management	7	6	[53]
Environment	Electrochemical CO ₂ reduction	12	8	[55]
	Swine manure slurry as liquid fertilizer	5	4	[56]

FUTURE DIRECTIONS

There has been both slow and rapid progress toward SDG17. The \$34 billion in net bilateral ODA disbursements to African nations in 2022 was a decrease of 7.4 percent from the \$38 billion in 2021. Slower growth in Internet users compared to the peak of the pandemic means that the goal of connecting everyone by 2030 will remain elusive without more investment in infrastructure and digital skills.

There has been no change to the preferential tariff treatment accorded by rich nations to LDCs, SIDs, and developing nations. Over the past five years, it has risen virtually continually [64].

A new era of quick progress towards reaching the Sustainable Development Goals by 2030 is being pushed for with strategic guidance from political leadership at a prominent level. As the 2030 Agenda and the SDGs approach their halfway point, the President of the General Assembly has called for this Summit. This conference is meant to be the highlight of the High-level Week of the United Nations General Assembly. The SDG Summit will serve as a clarion call for world leaders to gather, assess progress thus far, and commit to increasing their efforts. This is an opportunity to renew our dedication to a future in which no one is left behind. As a result of the 2030 Agenda's success in mitigating the cascading effects of multiple global crises, hope, optimism, and desire have been rekindled with respect to the plan [65].

As the globe becomes increasingly interconnected, collaborative networks of professionals from many sectors are generating innovation and breakthroughs in R&D. Advanced technologies enable the shift from centralized R&D hubs to be decentralized facilities, which improves adaptability, experimentation, and problem-solving. These trends foresee a world where researchers work



Fig. 4. Future directions of global collaboration and decentralized facilities in shaping the future of research and development.

internationally in real time using decentralized setups to speed innovation, flexibility, localized solutions, and resource efficiency. These trends foster open communication and seamless integration, moving R&D toward a connected, innovative, and impactful future as shown in Fig. 4.

The advancement of the UNSDGs and the EGD relies heavily on R&D World Links and decentralized facilities. These strategies provide chances to address global concerns and speed up sustainable development by encouraging collaboration, information exchange, and localized innovation. To fully realize their potential, however, there must be universal access, consistent regulation, and well-defined environmental goals. IAAM can create a more sustainable and resilient future by capitalizing on the synergies between R&D World Links and distributed facilities.

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