

# What is Impact?

*Generating Dividends of Economic Growth and Societal Benefits from Research and Innovation*

Anusandhan National Research Foundation

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## Executive Summary

Impact of R&D goes beyond publications and patents and must be eventually experienced by the society, both within and beyond a nation. Generating impact is a team sport, with every player active and contributing to the research enterprise of a nation having a designated, critical role, and where a player failing to deliver on this role is likely to derail the virtuous cycle of accelerating favorable outcomes. Impact is *multi-dimensional* and is a long-term *journey* with milestones and markers along the way. Thus, the three sets of players of the impact team sport, namely fundamental, use-inspired and translational researchers, must function in tandem, collaborating in agile ways over time. It also constitutes planting a million ideas and aspirations for the future capacity or human capital, considered the most important form of capital, to continue the impact journey and prepare the next generations of devoted and committed researchers, innovators and entrepreneurs.

An impact roadmap defines the impact pathways and markers to realize the outcomes and navigate the impact journey, guided by the high-level objectives of the impact journey and the vision of its endgame. The impact pathways are defined in terms of research productivity and capacity building, innovation to entrepreneurship and industry collaborations. The three sets of researchers use these pathways to generate the impact outcomes of research breakthroughs, leadership, eminence, resilience and a strong research infrastructure, while the educational roles builds robust future generations of researchers, learners, industry-ready professionals and entrepreneurs. Finally, the growing intensity of innovation activities strengthen national self-reliance and sovereignty while fueling a robust growth in national economy and welfare.

Anusandhan National Research Foundation defines its programs by impact-aligned high-level objectives, and we present the relevant pathways and markers for each of its programs. Specific programs stand out in prominence for each pathway of research productivity and capacity building, innovation to entrepreneurship and industry collaborations. Mentoring and guidance support, especially for the large-scale programs, and the access to tools and support services, such as SARAL AI, to demystify and democratize research through social media or other secondary dissemination channels constitute best practices. The funding programs must also be complemented by a programmatic guidance framework to assess the progress towards the impact outcomes as observed through the impact markers, and thus, evaluate their contribution to the advancement towards the endgame.

## I. Introduction

Impact of R&D goes beyond publications and patents. The impact of research, development and innovation investments must be eventually experienced by the society, both within and beyond a nation. This impact is boosted by virtuous cycles it can create for accelerating favorable outcomes, economic growth, welfare of the citizen and improved prospects of safety, security and productivity. Since the 1990s, government funding agencies around the world have moved away from the hypothesis that any investment in science is inherently good for the society without an explicit need for creating the pathways for channeling this good [Bornmann 2013]. With this recognition, over the past decades government agencies funding science and technology research around the globe have made several iterations for how impact-driven alignment is strengthened for their funding activities, commonly referred to as ‘broader impacts’ [Fini 2018]. While science commercialization or innovation has received significant thrust globally in the past decades [Cremonini 2018, Fleming 2019], it remains to be established what is a holistic and inclusive approach to pursuing impact that is responsive to a country’s specific needs and status in its research, development and innovation journey.

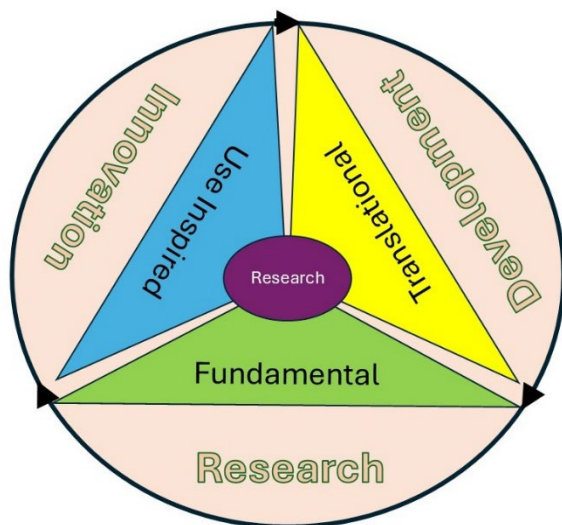


Figure 1: Impact Team: Generating Impact is a Team Sport.

Generating impact is a team sport; think of this as an “**Impact Team.**” As in any team sport, every player active and contributing to the research enterprise of a nation has a designated, critical role, where a player failing to deliver on this role is likely to derail the virtuous cycle of accelerating favorable outcomes. One set of players devote their energies to fundamental research, also referred to as basic, curiosity-driven or knowledge discovery research, driven by the same innate and fundamental curiosity that has implored humanity to understand the universe at all scales for the millennia. The second set of players are driven by the purpose of making the world better as they see it and thus define their role in the research enterprise by addressing research problems that are use-inspired, or applied, taking advantage of fundamental research advances to enhance economic growth, welfare of the citizen and improved prospects of safety, security and productivity. The third set of translational players utilize the fundamental or use-inspired research advances to design and develop tools, techniques, methodologies, technologies, products and services to realize their benefits for the economy and the society. This also highlights the point that impact is *multi-dimensional*, and that impact is a long-term *journey* with milestones and markers along the way. Thus, the three players of the impact team sport must function in tandem, collaborating in an agile way over time for a well-oiled virtuous cycle of accelerating favorable outcomes, as shown in **Figure 1**.

Specialization as reflected in the three sets of players matters, but bridges of collaboration between them is essential for one set of players to leverage the advances of the other, even if a single individual or team may not or cannot span the role of all three sets. The need to drive this collaboration between the three sets of players is urgent, with stages that are designed to accelerate technology transitions from fundamental to use-inspired to translational advances. This urgency is underlined by countries looking

to capture the unique economic and geo-strategic benefits from accelerating technology diffusion across these stages and broader spillovers via education, skilling and training.

Furthermore, the players of the impact team sport do not function in vacuum. There is a significant and essential infrastructure and supporting environment necessary to conduct the research and achieve the objectives of the research, whether fundamental, use-inspired or translational. Enriching this environment and strengthening the infrastructure is part of feeding the virtuous cycle for a holistic and inclusive approach to pursuing impact. This also constitutes planting a million ideas and aspirations for the future capacity or human capital, considered the most important form of capital, to continue the impact journey and preparing the next generations of devoted and committed researchers, innovators and entrepreneurs [Becker 2002]. This is necessary since investment in research, development and innovation is a long-term strategy for economic growth, wellbeing and prosperity, once combined with a

clear direction and sustained effort. Beyond a deliberate and thoughtful investment in preparing a workforce that considers R&D endeavor a career priority and makes the trade-offs to pursue it, appropriate investments must also be made towards a growing and vibrant infrastructure for supporting the innovation and translational activities. A clear direction and sustained effort behind the virtuous cycle must be guided by the vision of an endgame.

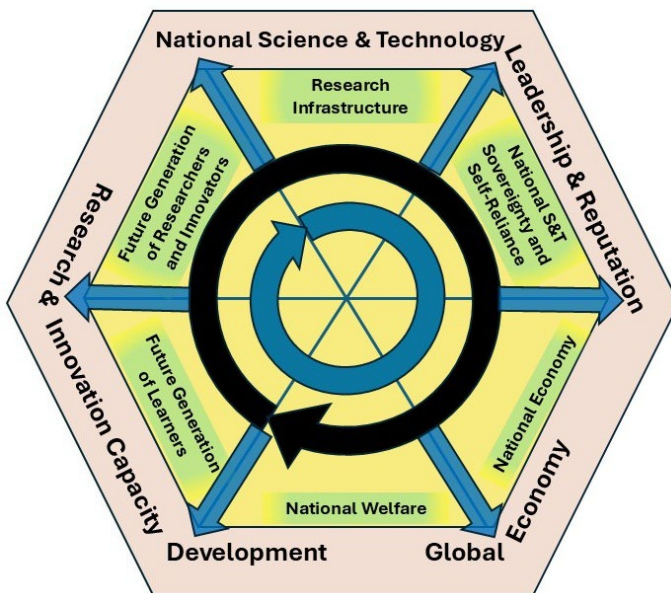


Figure 2: Impact Endgame for Beneficiaries, the Society, and the Nation

## II. Establish the Endgame

Over the past decades, several methods have been developed to evaluate the societal impact of government funding for research, development and innovation [Smit 2021].

Examples of these methods utilized by

different funding agencies globally include Payback Framework, Science and Technology Human Capital, Public Value Mapping, Monetization, Flows of Knowledge, SIAMPI (Social Impact Assessment through Productive Interactions), Contribution Mapping, Impact Narratives, and Evaluative Inquiry. These methods are applied at an individual project level or at a funding program level, as they are deemed fit. Each of these methods, as their names suggest, have a strong qualitative aspect to the evaluation in addition to the quantitative elements. Government research, development and innovation funding is seen as a critical factor in maintaining and improving growth, welfare and international competitiveness [Bloch 2014], thus meriting a greater emphasis on assessing the impacts of funding and how funding can best be designed to promote socio-economic progress. Noting that funding has a complex mix of direct and intermediate effects, a *concept of additionality* captures the catalytic nature of funding, at the input, output and behavioral levels.

The strong catalytic force of change and advancement towards growth, welfare and international competitiveness that government funding of research, development and innovation can serve demands

defining the endgame. The *endgame* is the vision of the long-term outcome of sustained effort of generating impact from government research, development and innovation funding. This vision is encapsulated in Figure 2. At the core of the endgame figure are two virtuous cycles, the inner one that runs in a shorter time span, while the outer one unfolds in a longer time span. The shorter virtuous cycle is created by intentionally using the research infrastructure available at a point of time to generate favorable outcomes for economic growth, welfare of the citizen and improved prospects of safety, security and productivity. The intentionality also assigns effort to prepare the future generations of learners, researchers and innovators, thus seeding an expansion of the research, development and innovation enterprise of the nation. The outer virtuous cycle reflects how the growing size and quality of research, development and innovation workforce, i.e. research & innovation capacity development, feeds into expanding the research infrastructure and the downstream economic growth, welfare, safety, security and productivity of the citizens.

For an inclusive and holistic framing, we conceive the nation’s research Infrastructure to include the human capital invested in the research, development and innovation enterprise of the country. This is an expansive view from the standard scoping of research infrastructure in term of regular to highly specialized equipment, facilities, materials and specimen, data repositories and computational resources. For a research, development and innovation supportive scoping of research infrastructure, we also include professional organizations, publication and dissemination channels, testbeds, sandboxes and incubators available to researchers and innovators for achieving their objectives. This inclusive and holistic scoping of research infrastructure is essential to encapsulate the virtuous cycles shown in Figure 2 towards achieving the endgame. Unless the research enterprise supported by the appropriate research infrastructure is not driven by the needs of the nation, the societal impact of government funding for research, development and innovation will remain deficient, irrespective of the methodology used to evaluate it.

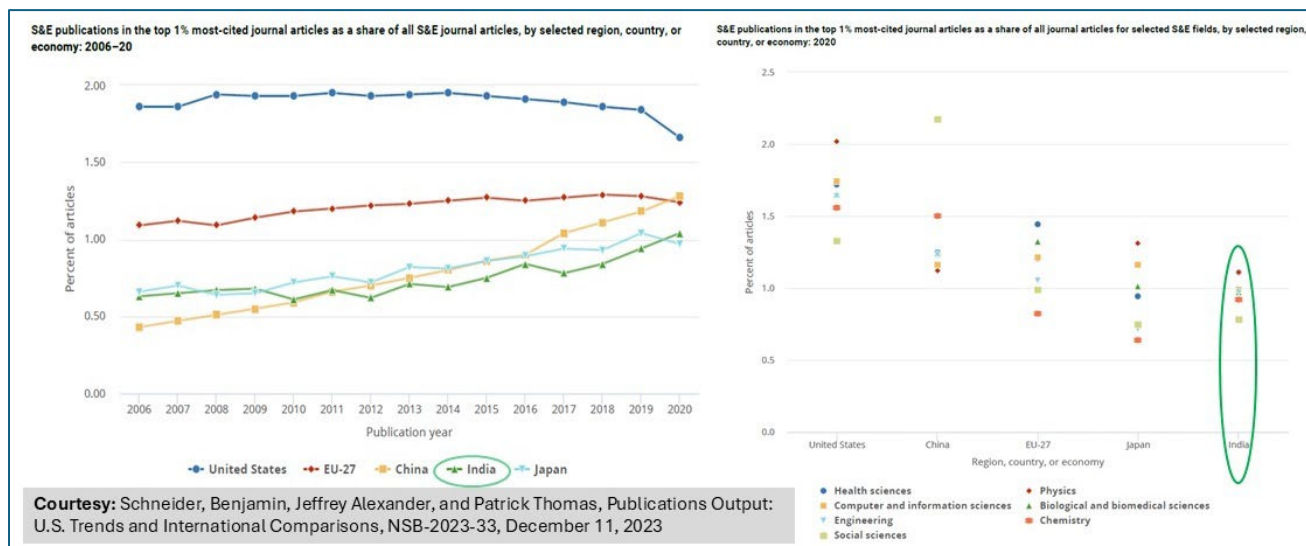


Figure 3: Fraction of top cited papers trend and by discipline among science and engineering disciplines.

National science and technology sovereignty and self-reliance is the ability of the nation’s research enterprise to produce high quality outputs and outcomes that make relevant and significant contributions to the nation’s and its citizen’s safety and security, while creating prospects for wellbeing

and prosperity. In 2023, India produced 6.97% of the total global articles in science & engineering disciplines compared to China leading the roster at 28.48%, followed by the United States, at 13.16% [National Science Board 2025]. Figure 3 shows the trend of top cited articles percentage by country across all science and engineering disciplines and shows that India's profile has been steadily improving from 2006 through 2020. The right panel of the figure also indicates that India showed relatively higher impact in physics than in other fields and had particularly notable impact in astronomy and astrophysics [Schneider 2023]. From 2002 to 2023, publications from authors based in India grew 1,233% (from 1,633 to 21,761) in biotechnology-related disciplines, where by 2022 India beat the US in number of articles for both biotechnology and semiconductors related research [National Science Board 2025]. An intentional pursuit of impact can propel all the other science and engineering disciplines to rise in significance and prominence.

The tandem role of the three players, namely fundamental, use-inspired and translational researchers, creates a well-oiled virtuous cycle of accelerating favorable outcomes with a positive effect on the economy, society, culture, public policy or services, health, the environment or quality of life [Bührer 2022]. These dividends from a government funding agency's investments are specifically realized when they are combined with *multichannel diffusion* of innovations and an active participation of the industry in the nation's research enterprise [Kang 2020, Bikard 2020]. These strategic investments by industry are key to the long-term economic growth trajectory, and where relevant, multichannel diffusion aided by policy support from the regulatory bodies can ensure a steady elevation of national welfare, health and quality of life.

Staying the course for the long-run and continuing to reap the benefits of a virtuous cycle set in motion critically requires preparing the next generation of talented and prepared researchers, innovators and entrepreneurs. Nations recognize that their scientific competitiveness depends not only on discovery

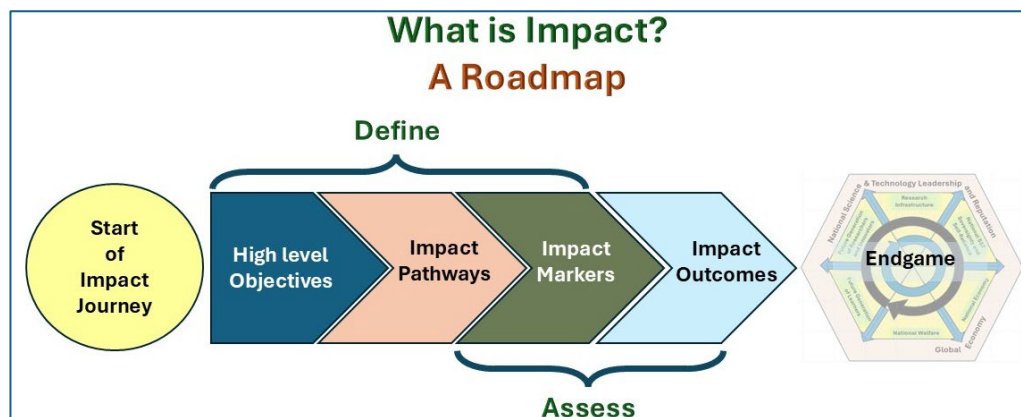


Figure 4: The roadmap for the impact journey.

but also on the diffusion and retention of tacit knowledge, particularly through students who embody and transfer expertise [Combemale 2025]. Beneficiary of the diffusion need not be limited to

formally registered students in educational institutions but must be accessible to the broader population of learners looking to upskill or be inspired by the discoveries and innovations.

Finally, as shown in Figure 2, the two virtuous cycles active at two timescales uplift the national science and technology reputation and establish the nation's leadership in all key science and technology domains. The outcomes and impact from the research, development and innovation investments get noticed beyond the nation [National Science Board 2025, Schneider 2023], with a special recognition and credit given to the nation's noteworthy and breakthrough outcomes [Fleming 2007, Corsini 2023]. It

is observed that in their respective eras of technological ascension, Japan, Korea, and China failed to pursue technological breakthroughs or disruptive innovations [Frey 2021], which prevented them from becoming a global research and innovation leader, however in the past decades, China has turned the page for its recognition and pursuit of high-quality educational enterprises [Zhu 2024] and breakthrough innovations [Steinfeld 2014, Dai 2025].

The national economic vibrancy and global science and technology reputation and leadership naturally result in strong spillovers for the global economy, not only in terms of the highly attractive and talented human capital but also from the knowledge and innovation diffusion. Science and technology benefits emanating from the nation are experienced around the globe, creating new growth opportunities for the world economy. That is the endgame for a sustained and focused effort of impact-driven research, development and innovation.

In the next sections, we will follow the roadmap laid out in [Figure 4](#) to define the impact pathways and markers to navigate the impact journey. Sections I and II defined what is impact and described the high-level objectives of the impact journey, as well as built the vision of its endgame. Once the impact high-level objectives, pathways and markers are defined, a funding agency must align its funding programs with them and construct a programmatic oversight framework to assess the progress towards the impact outcomes as observed through the impact markers and evaluate its advancement towards the endgame.

### III. Defining Pathways for Impact

Researchers need to have a persistent intent to deliver impact, and this must be cultivated, measured and amplified. The intentionality necessary for generating impact cannot be understated. This intentionality is the fuel for collectively navigating the pathways to realize the endgame. The exact nature and characteristics of the pathways must be identified and laid out towards each element of the virtuous cycles discussed through [Figure 2](#) in [Section II](#). The three sets of indispensable players of the impact team sport, namely fundamental, use-inspired and translational researchers, are the key entities driving the navigation progress. Following their roles defined by research, development, education, and innovation encapsulated in [Figures 1 and 2](#), we present the nature and characteristics of the pathways for each of these role’s alignment with impact generation.

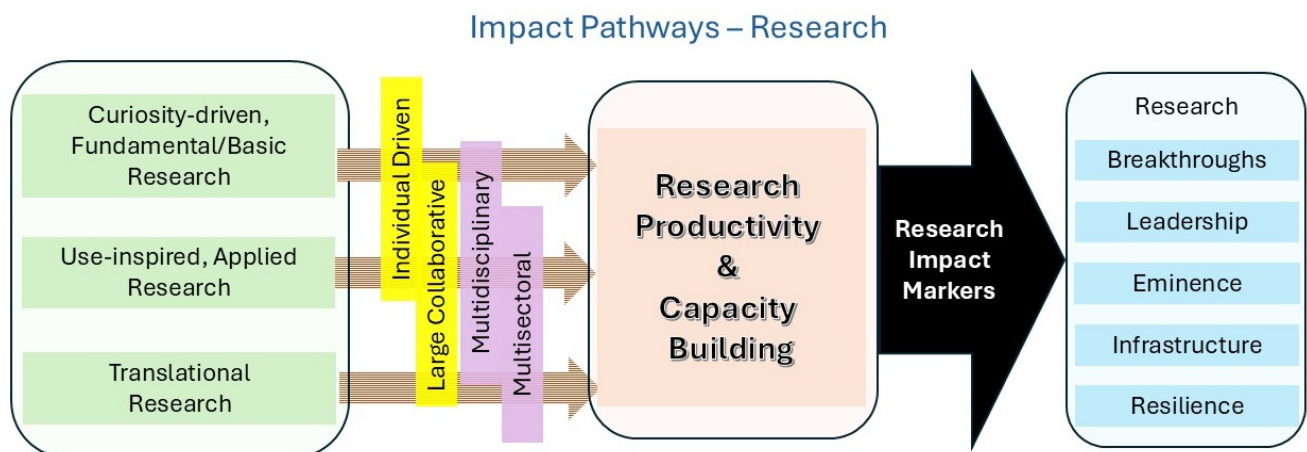


Figure 5: Impact Pathway for Research toward the Endgame.

The critical objective of the research enterprise, irrespective of the type of player, is to have high research productivity. Productivity that is aligned with impact is not only measured in terms of quantity but is most unequivocally measured in terms of the quality of the outputs and outcomes. In the case of use-inspired and translational research, it is also measured in terms of the compelling nature of national or societal need being addressed. Responding to the long tail of innovation [Fleming 2007], the efforts must be ambitious with an appetite for risk towards seeking breakthroughs and disruptive innovation, as discussed in **Section II**. The second major objective of the research enterprise is capacity building, which refers to standing up facilities, laboratories, equipment, tools, specimen and materials, datasets and repositories, and computational infrastructure that other researchers and investigators can utilize, where possible beyond the institutional boundaries. A ubiquitous culture of high research productivity devoted to expanding the research capacity naturally lead to the creation of a resilient research enterprise.

Researchers may choose to tackle the challenges of their research domains individually, in small teams of researchers or in large collaboratives, which may be supported by different funding programs or levels of funding. In many disciplines, irrespective of the type of research, fundamental, use-inspired or translational, collaborative efforts are an imperative since in a highly specialized world, specific expertise even within a single discipline resides in different individuals or institutions, including the specialized equipment or facilities needed for the work. Moreover, breakthrough research either aims to push the frontiers of disciplines or contributes at the boundaries of disciplines. Many so-called ‘wicked problems’ or ‘grand challenges’ faced by the nation, society or the world must be addressed in highly multidisciplinary teams, bringing together a diverse set of expertise and skills. For use-inspired and translational research, the research objectives may need multisectoral consideration and involvement. All of these factors contribute to how the researchers pursue their impact-aligned research objectives.

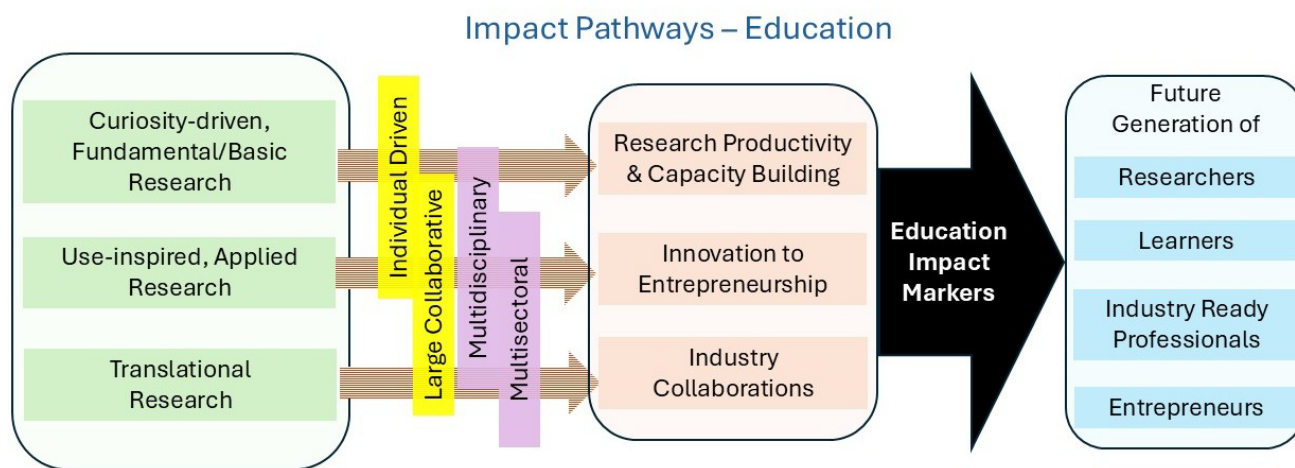


Figure 6: Impact Pathway for the Educational Enterprise toward the Endgame.

In **Figure 5**, the three types of researchers contribute to research productivity and capacity building suitable for their respective context to generate the impact. Fundamental or curiosity-driven researchers will most often be individual or small team investigators, but in some disciplines as discussed above may require functioning in large collaboratives and work across experts from various disciplines. Use-inspired researchers may operate in small or large collaborative teams and are more likely to function across disciplines as needed by the use-context of their research domain. The context may also require

multisectoral engagement. Translational researchers are in many ways similar to use-inspired researchers, however the complexity of translational activity would often require larger collaboratives, routine multidisciplinary and multisectoral engagement.

The three sets of indispensable players of the impact team sport contribute in some common and some unique ways through their educational role. Training students to conduct research of the specific nature is a well noted educational role, however what is not sufficiently emphasized is training the trainees with the skill to communicate the passion and the content of research for dissemination to a broader variety of audiences. Moreover, irrespective of the type of research, learning the skill to ask the right kind of questions to push the frontiers or boundaries of disciplines must also be imparted to students at all levels, not necessarily only to those committing to a career in research. Becoming a critical thinker and not taking anything at the face value is an intellectual capacity researcher of all types can instill into the audiences they interact with in all contexts, classrooms, laboratories, professional events, social media, and society at large. This pathway contributes to future capabilities of research productivity and capacity building.

As shown in Figure 6, use-inspired and translational researchers have the opportunity to utilize their contexts of research to train students and engage broader audiences toward seeding the spirit of innovation and entrepreneurship. They engage with stakeholders, such as startup ecosystems, incubators, industry professionals and corporates for both understanding the research needs and the innovation and commercialization landscape. Engaging students in the researchers' industry collaborations or entrepreneurial initiatives exposes the students to the industry landscape, as well as presents the attractive prospect of becoming an entrepreneur. These constitute the educational pathway of impact to feed into the virtuous cycle of expanding the research, innovation and entrepreneurship prospects of the nation.

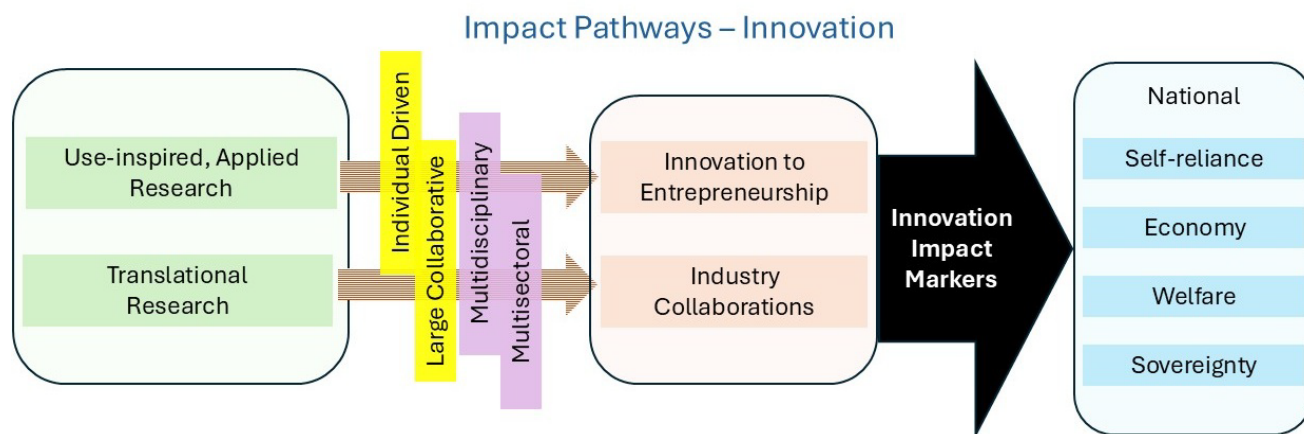


Figure 7: Impact Pathway for Innovation and Translation toward the Endgame.

Figure 7 captures the innovation pathway for impact-driven research conducted by use-inspired and translational researchers. Innovation benefits the society by commercial, social, cultural, policy or regulatory advances that have a positive effect on, or provide change or benefit to the economy, society, culture, public services, health, the environment or quality of life [Bührer 2022]. Towards this end, the researchers must engage appropriate industry, regulatory, policy, or nonprofit stakeholders to realize the impact, as well as access translational avenues through industry collaboration or entrepreneurial

initiative. Compelling dissemination ability and creating visibility for the innovation to appropriate stakeholders is most critical for this impact pathway. Conducting the research enquiry with the right players of collaborative, and responsive engagement of inter- and multidisciplinary expertise and multisectoral involvement is also paramount for impact realization. By way of the above undertakings, the innovation impact generates the virtuous cycle outcomes of national self-reliance, sovereignty, and growth in national economy and welfare.

#### IV. Impact Markers, Indicators, Measures and Stories

The impact pathways of research, development, innovation and education to realize the endgame are activated by the projects selected through a rigorous merit review process of a government funding agency. The projects' duration of a few years may not be adequate to realize the impact they set out to achieve; therefore, it is imperative to conceive ways to pick up the right signals to determine if the projects are on track to make the eventual impact. While the terms measures, indicators, and markers are often used interchangeably, a measure tends to be a quantitative direct, precise, and objective recording of a specific attribute. Hence measures may not serve the purpose of picking signals of progress towards the eventual impact. In comparison, indicators or markers pick broader, sometimes qualitative, signals that provide evidence about progress, performance, tendency or trend. They are also useful as an approximation of an otherwise complex phenomenon.

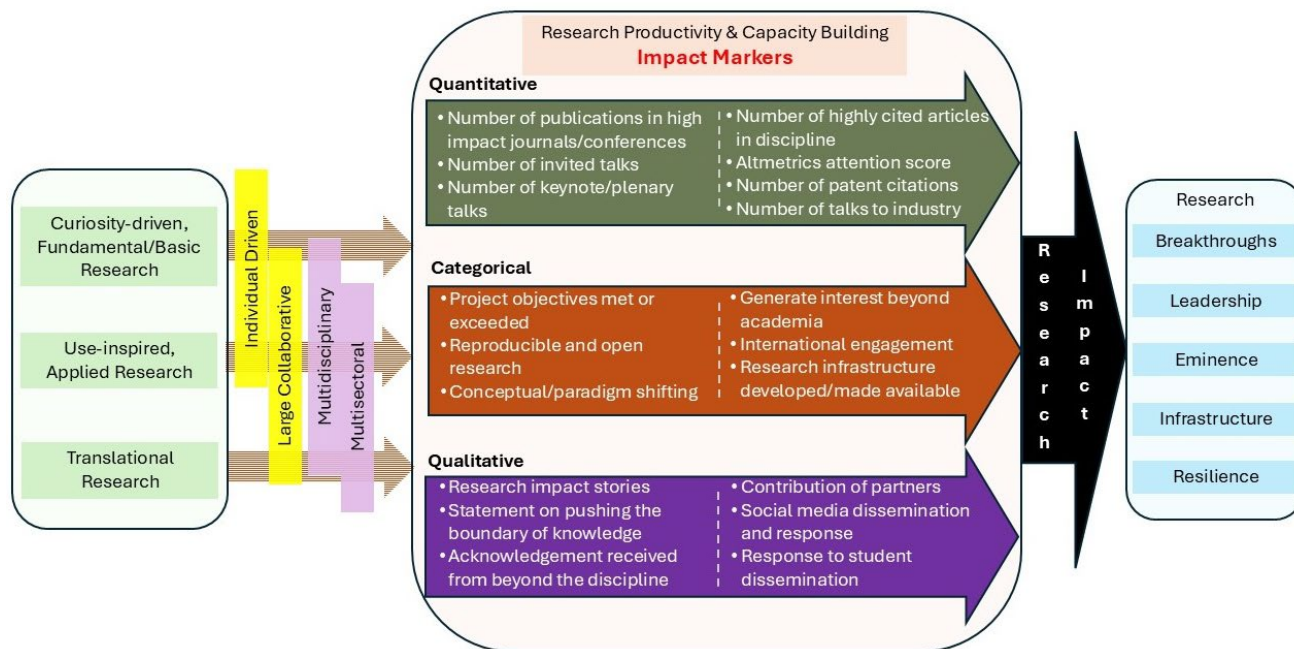


Figure 8: Research Impact Markers for Research Productivity and Capacity Building Impact Pathway

Markers or indicators can be *quantitative* or *categorical*, while *qualitative* signals can also be captured through stories, case studies or narratives of specific use-cases. We will explore the impact markers suitable for the research, education and innovation roles of the three indispensable sets of players of the impact team sport. The choice of markers should be responsive to drive impact, instill accountability in all stakeholders, as well as nurture the necessary persistence essential for impact in the research enterprise.

Through the pathway of research productivity and capacity building, discussed in Section III, the three sets of players, namely fundamental, use-inspired and translational researchers, perform their respective roles in their research domains to make an impact. Figure 8 describes the quantitative, categorical and qualitative markers by which this progress towards impact may be observed. While all impact markers may not be relevant for every project or researcher type, a subset of markers would be relevant for each project or researcher. The impact markers captured in Figure 8 are not meant to be exhaustive, however they constitute a good representation of relevant impact markers to advance towards the outcomes of research breakthroughs, leadership, eminence, resilience and strong research infrastructure, and the eventual endgame.

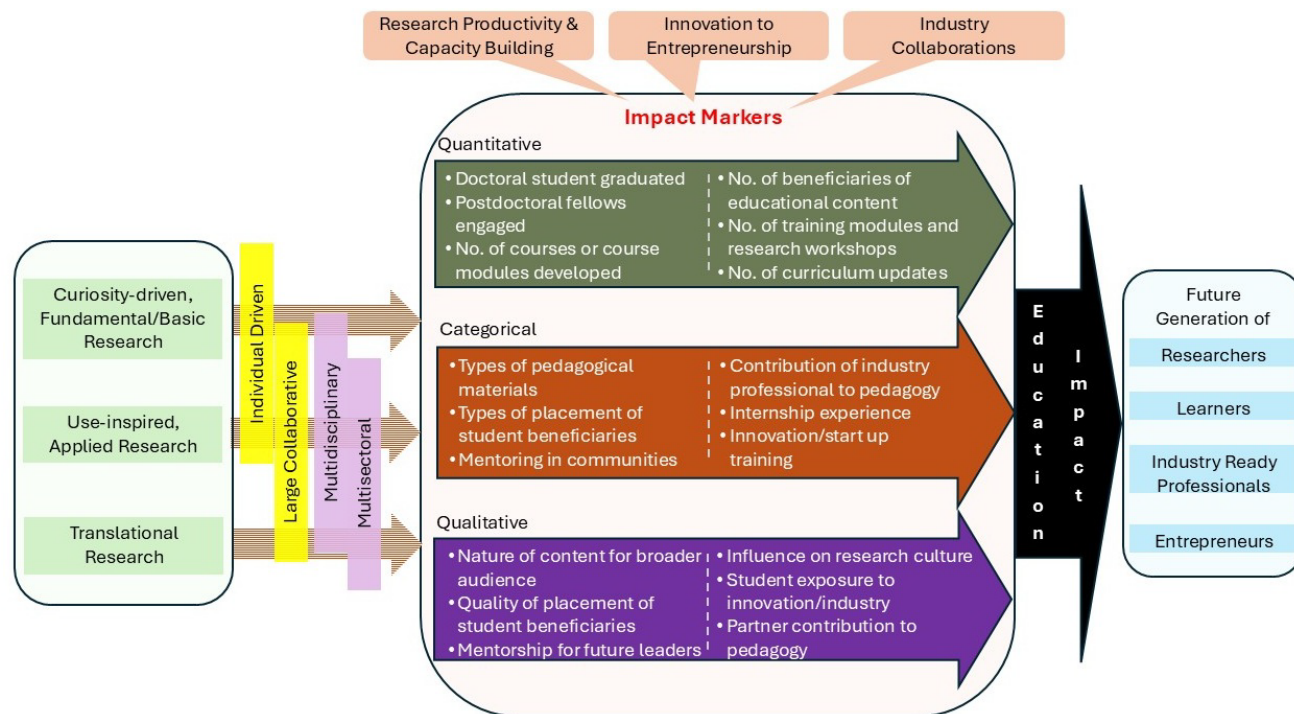


Figure 9: Education Impact Markers for Research Productivity & Capacity Building, Innovation to Entrepreneurship, and Industry Collaborations Impact Pathway

The quantitative impact markers in Figure 8 don't include the common indicators of research productivity, such as 'number of peer reviewed papers,' 'number of conference talks,' or 'number of citations,' since these don't adequately lend to measuring quality of research across all disciplines, or its ability to generate impact, and can be prone to manipulation [Chaddah 2018, Aksnes 2019, Corsini 2023, Ibrahim 2025]. 'Number of publications in high impact journals/conferences' is a baseline marker for indicating eventual impact. To build on that, 'highly cited articles,' which fall among the top percentiles for the discipline by number of citations, more strongly reflects quality of research [Schneider 2023], including variants such as, 'number of disruptive citations' [Yang 2025]. 'Citation in patents,' 'nonpatent reference' and 'patent forward citations' are important markers for the translational value of research [Fleming 2019, Verhoeven 2016, Quemener 2024]. Research leadership and eminence is captured by 'number of invited, keynote or plenary talks,' and similar indicators, such as 'editorial roles' in premier peer-reviewed research outlets. Seeking breakthroughs in research and the persistence it requires is captured in terms of 'pushing disciplinary or inter-disciplinary boundaries' or establishing 'conceptual/paradigm shifts' through research [Chaddah 2018]. Strengthening the research ecosystem

must maximize the value derived from creating and sharing research infrastructure, captured through a marker [Bornmann 2013].

Designing research projects with practical impact in mind, as for use-inspired and translational research, needs delivering clear and accessible findings, disseminating insights beyond the academic circles, and demonstrating tangible benefits to practice [Dwivedi 2024], which are captured through ‘talks to an industry audience’ marker and several additional categorical and qualitative markers in Figure 8. In this regard, while ‘generate interest beyond academia’ and ‘acknowledgement received from beyond the discipline’ may appear duplicative, the former is a categorical marker for types of interest received for research products beyond academia for use-inspired or translational research and the latter targets the inter-disciplinary visibility of products from fundamental research. For all researchers to broaden dissemination and democratize research, including training students to broadly share the excitement of discovery, use of social media channels is captured by several quantitative and qualitative markers, the latter to specifically overcome the limitations of quantitative Altmetrics [Sugimoto 2017, Bornmann 2018, Tahamtan 2020]. ‘Altmetric attention score’ is chosen as a sample quantitative marker to capture a weighted indication of the volume and type of online attention a research publication receives [Ou 2024, Shueb 2024].

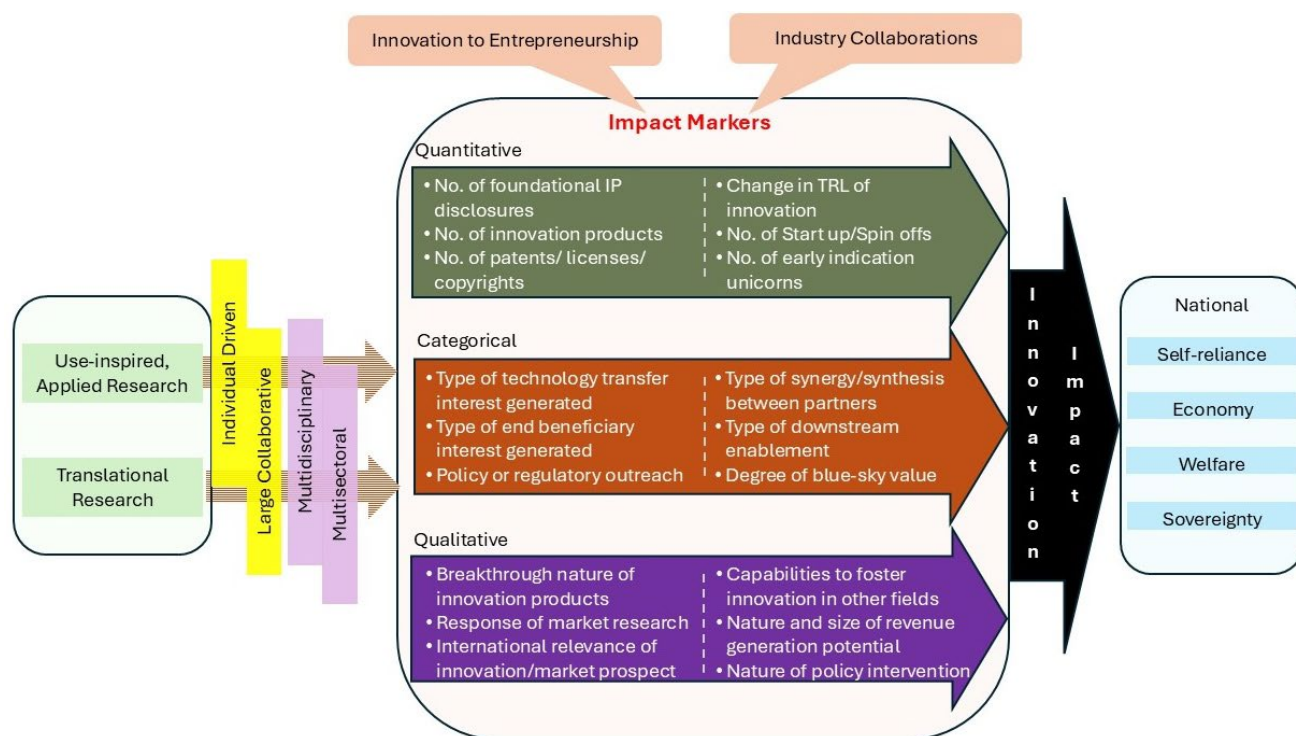


Figure 10: Innovation Impact Markers for Innovation to Entrepreneurship and Industry Collaborations Impact Pathway.

Training the next generations of researchers, innovators and entrepreneurs is critical for setting a self-propagating virtuous cycle in motion, as discussed in Section II. Figure 9 provides a key set of sample impact markers relevant for all three types of researchers using research productivity & capacity building, innovation to entrepreneurship, and industry collaborations pathways for educational impact. Once again with emphasis on both quantity and quality, sample markers are chosen of quantitative, categorical and qualitative types. Besides mentoring doctoral students and postdoctoral fellows, providing research experience to masters, undergraduate and high school students richly expands

sharing the excitement of research and innovation, while also creating a stronger pipeline for future researchers and innovators [Bornmann 2013]. Pedagogical materials & courses development and curriculum enhancement based on research discoveries and knowledge creation, including for broader audiences such as through MOOCs, popular science video or gaming content, etc., uplifts the entire population's science and technology prowess [Dietz 2024]. Quality of job placement, internship experience, student exposure to industry professionals, all support generating cohorts of industry-ready graduates. Industry and innovation partners contributing to the educational enterprise, and training students to become innovators and entrepreneurs is invaluable for establishing strategic industry-academe links [Pertuze 2010]. Sustained effort captured by these impact markers will pave the way to the educational outcomes of robust future generations of researchers, learners, industry-ready professionals and entrepreneurs.

The innovation to entrepreneurship and industry collaborations pathways are utilized for the innovation impact of the two relevant sets of researchers, namely use-inspired and translational. A sample of key quantitative, categorical and qualitative impact markers for innovation are included in [Figure 10](#). Number, variety, and quality of innovative products is the hallmark of innovation impact, which is captured among the impact markers by number of IP disclosures, patents, licenses, and copyrights. Innovation that moves along the Technology Readiness Levels (TRLs) or advances to a startup or a spin-off stage, and bears indications of emerging as a unicorn are additional quantitative innovation impact markers.

Research translation and impact is also generated through industry collaborations, or regulatory or policy advances, captured by impact markers such as 'type of technology transfer interest generated,' 'policy or regulatory outreach,' 'nature of policy intervention,' and 'market research findings' [Steinfeld 2014, Frederiksen 2017]. Breakthrough innovation or its relevance at the international scale highlights the significance of the innovation, where patent quality or its blue-sky value may be significant [Fleming 2007, Higham 2021]. Some innovations would trigger a downstream impact in the value chain or in related fields, while others developed in large project's partnership inherently have innovation benefits realized by the synergy between partners, and especially the industry partners [Kang 2020, Bikard 2020]. All of these innovation impact markers at an increasing volume would feed into national self-reliance, sovereignty, and robust growth in national economy and welfare.

## **V. ANRF Programmatic Impact Landscape**

The Anusandhan National Research Foundation (ANRF) is an apex and unique research, development and innovation funding government agency of the Government of India. Its uniqueness is etched in its mission being impact oriented at the very inception, as opposed to many other similar and well-established agencies around the globe recognizing the need for impact alignment years after their inception [Bornmann 2013]. The ambitious vision of ANRF aims to provide support to all three sets of indispensable players of the impact team sport through its programmatic portfolio, firmly anchored in the notion that 'there is no deep-tech possible without deep-science.' The current set of ANRF programs, and the new ones that will be created in the future, will be embedded in the impact framework developed here, while ensuring supporting services are available for all programmatic beneficiaries towards compliance.

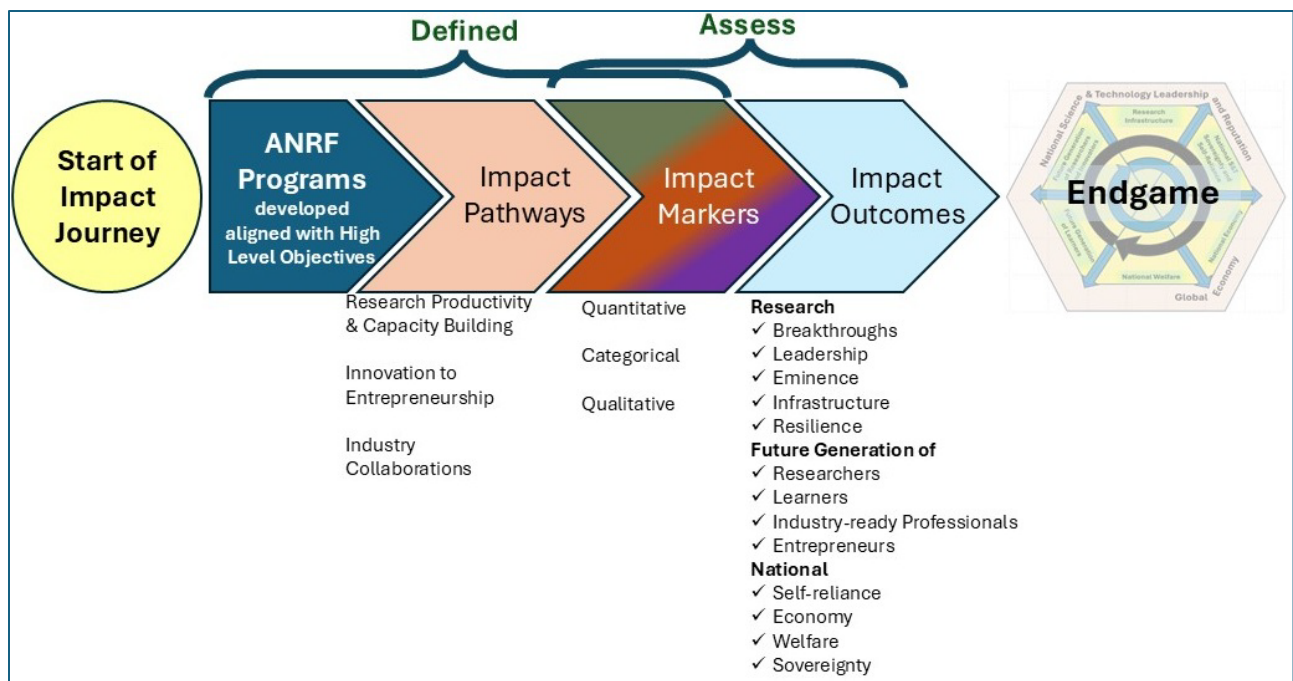


Figure 11: Overview of ANRF Programmatic Journey to the Endgame.

Section II laid out the endgame, which is the vision of long-term outcomes of sustained impact generation from government research, development and innovation funding, encapsulated in Figure 2. Following the roadmap of Figure 4, Sections III and IV identified the impact pathways, their relationship with impact outcomes, and the impact markers to observe progress on the research, education and innovation roles of the three sets of researchers. Figure 11 instantiates the roadmap of Figure 4 for the current set of ANRF programs and the programmatic path for ANRF programs to achieve the endgame, where for ease of linking, the color coding of each element of the figure is matched with its corresponding representation in Figure 4 through Figure 10. Each program in the ANRF programmatic portfolio will utilize the set of relevant impact pathways, from among research productivity & capacity building, innovation to entrepreneurship, and industry collaborations, to target impact outcomes, and will be observed for progress by the relevant set of quantitative, categorical and qualitative impact markers.

The research contributions of the programs will seek to achieve research breakthroughs, leadership, eminence, resilience and a strong research infrastructure, while the educational contributions will seek to build robust future generations of researchers, learners, industry-ready professionals and entrepreneurs. Finally, the growing intensity of innovations from the programs will strengthen national self-reliance and sovereignty while fueling a robust growth in national economy and welfare. In rest of this section, we establish the program-level mapping of impact pathways for the research, education and innovation roles to achieve the respective impact outcomes, and in turn, the endgame. The profile of each current ANRF program in terms of the three roles and the impact pathways naturally lends to the set of relevant impact markers discussed in Section IV to observe progress of projects funded by the program.

For the research role, the relevant pathway of research productivity & capacity building are placed on the two axes of the plot in Figure 12. Each of the current ANRF programs is placed in this two-

dimensional plot for the program's emphasis on research productivity versus capacity building. As such, all programs in the plot must contribute to both research productivity and capacity building, however their position in the plot emphasizes their relative difference against each other. The fan out of each program cluster depicts the relative magnitude of contributions each project may make within a program, with an increasing number of them making greater contributions. Three clusters stand out in this regard containing the three most significant programs, namely the Mission for Advancement in High-impact Areas (MAHA) series, the Advanced Research Grant (ARG) and the Partnerships for Accelerated Innovation and Research (PAIR).

The Advanced Research Grant (ARG) and the Inclusivity Research Grant (IRG) are core research funding ANRF programs, with individual or small team of investigators benefitting from research funding for projects of 3 years duration, that may be extendible to 5 years in some cases. This support for fundamental or use-inspired research is heavily defined by research productivity, with a baseline

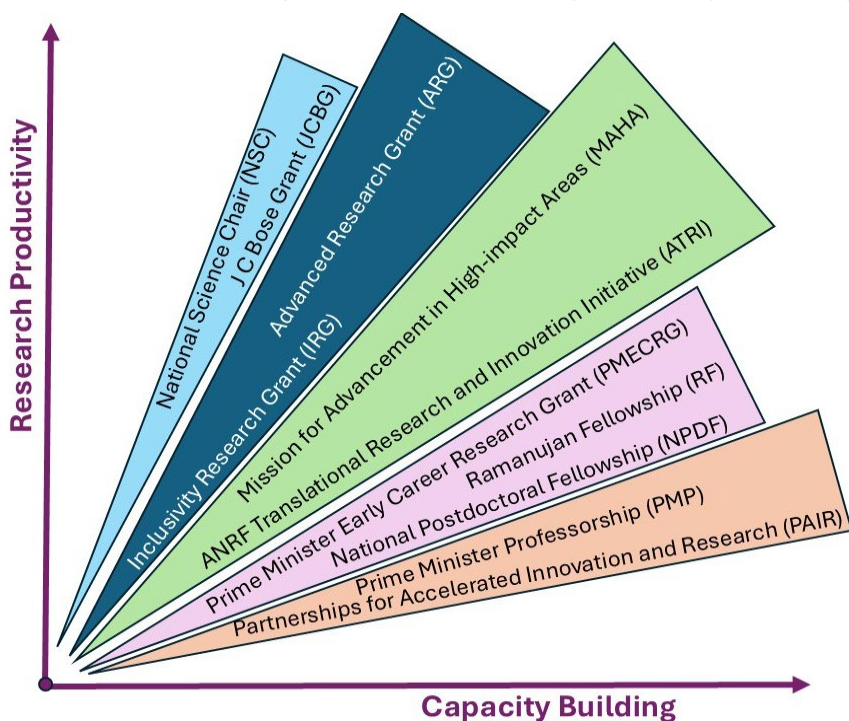


Figure 12: Research Pathway alignment of ANRF Programs by Research Productivity vs. Capacity Building

investment toward research capacity building. The National Science Chair (NSC) and J C Bose Grant (JCBG) are individual-specific grants that are strongly geared towards research eminence, hence productivity, but may offer possibilities of expanding research capacity from accomplished and nationally or internationally well-networked researchers.

The Mission for Advancement in High-impact Areas (MAHA) series of ANRF programs support large collaborative projects focused on outcomes for addressing India-specific

pressing challenges. These large investments entail that the program supports fewer projects, and are often collaborations between academia, research laboratories, industry and startups. The outcomes focus of these programs implies that the MAHA programs have both a high emphasis on research productivity, specifically use-inspired and translational research, and research capacity building. ANRF Translational Research and Innovation Initiative (ATRI) is designed to create translational centers in sector-specific and focused areas for developing innovative technologies leveraging strategic partnerships. These initiatives aim to strengthen India's translational research ecosystem by supporting the advancement of promising technologies from TRL 4 to TRL 7. Hence, ATRI projects would richly contribute to translational research productivity and capacity building.

The Prime Minister Early Career Research Grant (PMECRG), Ramanujan Fellowship (RF), and the National Postdoctoral Fellowship (NPDF) are fundamentally research capacity building programs

designed to seed research careers of young professionals, and in doing so, giving a boost to their research productivity. Finally, the Prime Minister Professorship (PMP) and Partnerships for Accelerated Innovation and Research (PAIR) are designed as individual and inter-institutional research capacity building programs, respectively. Therefore, these projects will strongly contribute to research capacity building, expand the research infrastructure and improve the research productivity of a growing population of researchers.

Figure 13 organizes the current ANRF portfolio of programs for their contribution to educational outcomes organized by research productivity & capacity building, innovation to entrepreneurship, and industry collaborations pathways. The size of each box is proportional to the relative extent of contribution each program is likely to make to the educational outcomes, with the placement of each box by the three pathways being indicative of the nature of educational contribution the program is likely to make. The MAHA series of programs' large presence in the far right of the figure indicates that they will contribute to the educational enterprise through industry collaborations and entrepreneurship-oriented opportunities, while the ATRI projects will fundamentally contribute to education through the industry collaborations.

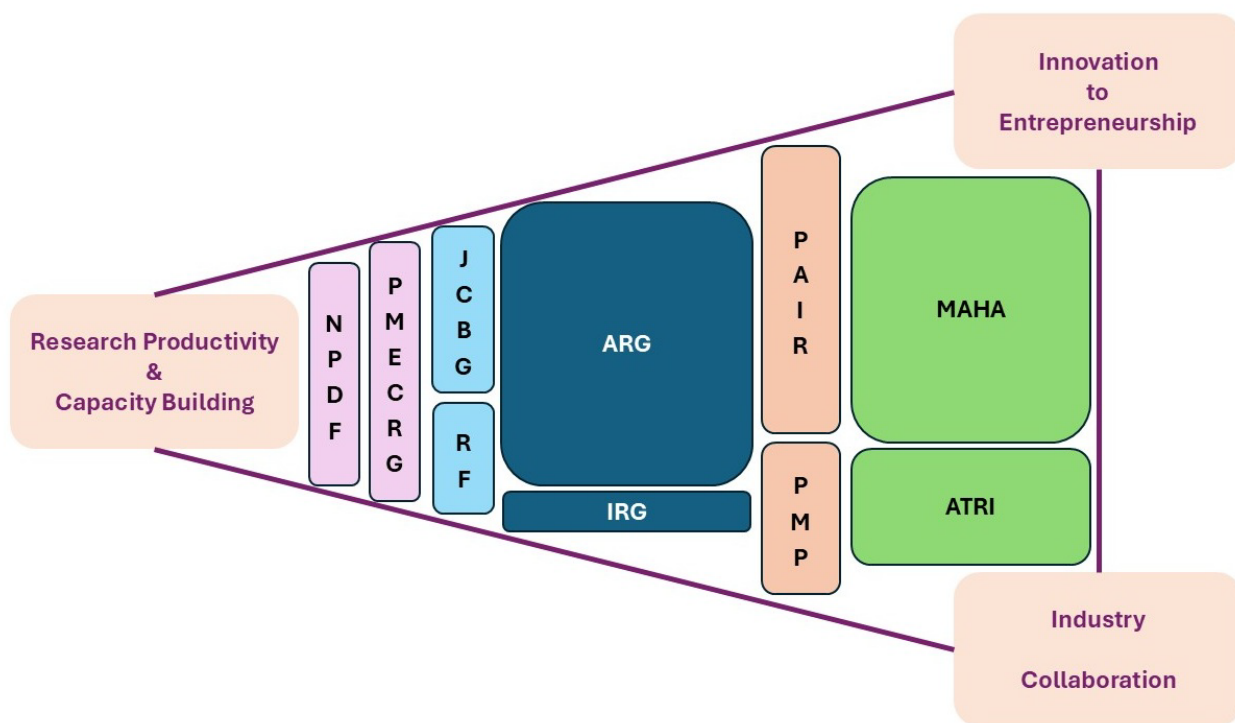


Figure 13: Education Pathway alignment of ANRF Programs by Research Productivity & Capacity Building, Innovation to Entrepreneurship, and Industry Collaborations.

The ARG, PAIR, IRG, and PMP programs feature in the middle of the three pathways, thus are envisioned to contribute by a combination of the three pathways depending on the fundamental, use-inspired or translational nature of projects underlying these programs. The NPDF, RF, PMECRG, JCBG and NSC are flushed in that order at the left end of the figure, since being individual-centric programs, the greatest educational contribution these projects are expected to make is through research productivity & capacity building pathways. As stated earlier, depending on the contribution pathway of a program or a specific project within each program, a set of impact markers naturally align to observe their progress.

For the innovation role of use-inspired and translational researchers, the relevant subset of ANRF programs are organized in Figure 14. Once again, the size of each box is proportional to the extent of contribution each program is likely to make towards innovation outcomes, with the placement of each box by the two relevant pathways being indicative of the nature of innovation contribution the program is likely to make. The MAHA series of programs are once again most significant for innovation outcomes, equally utilizing both industry collaborations and entrepreneurship pathways. ARG, PAIR, PMP, and IRG, in that decreasing order simply due to the relative size of these programs, will contribute to the innovation outcomes utilizing both the pathways on account of use-inspired projects funded by these programs. Finally, by design the ATRI program will contribute to the innovation outcomes more heavily through the industry collaborations pathway. This mapping of ANRF programmatic profile demonstrates that it richly spans the research, education and innovation outcomes to resolutely advance towards the endgame, as described in Figure 11.

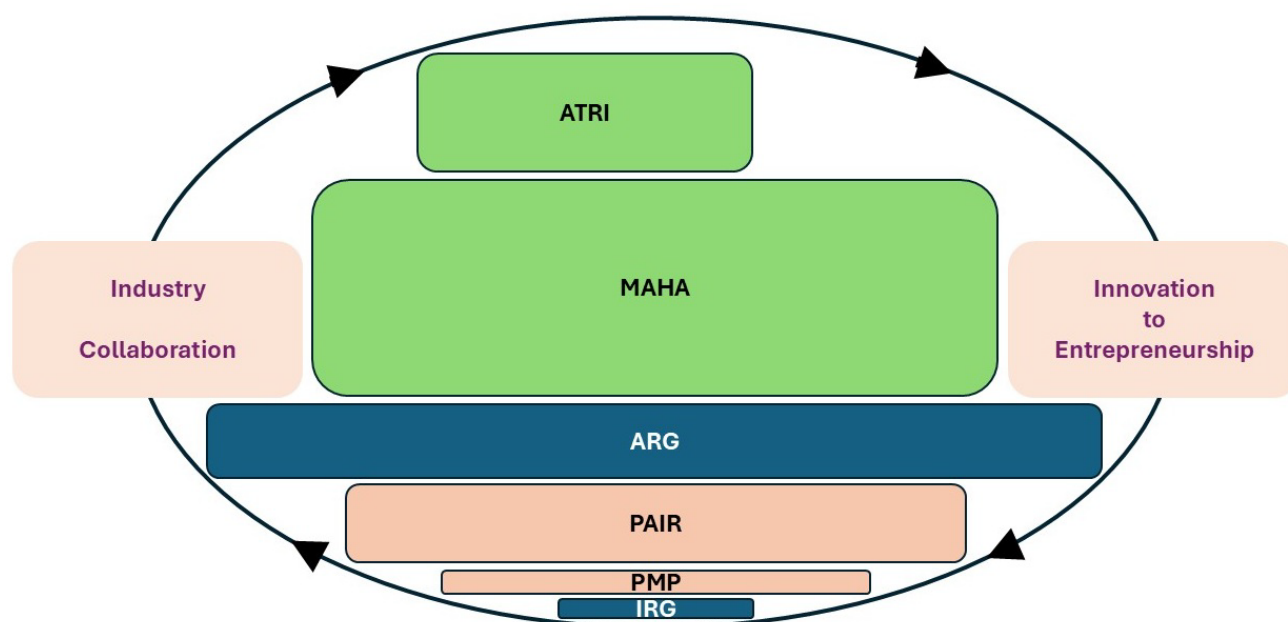


Figure 14: Innovation Pathways alignment of ANRF Programs by Innovation to Entrepreneurship, Industrial Collaborations

## VI. Operationalizing the Programmatic Impact Framework using Impact Scorecard

Generating research breakthroughs or translational unicorns is a marathon, probably more accurately, a relay marathon, since it requires persistence, stamina and collaborative willingness and coordination between different players. In these pursuits, grand or noteworthy success is realized after many failed but resilient attempts that mostly go unnoticed. A funding agency cannot just incite this pursuit via providing the funding through its various well-crafted programs or afford to remain a passive spectator of the tedious and strenuous relay marathon towards research breakthroughs or translational unicorns. It must operate as a partner, enabler, motivator and assessor of progress. This is especially true for the large-scale and complex programs, such as the ANRF MAHA series, the ATRI, and the PAIR programs.

Becoming mobilized towards impact is also a *call to change* for the community benefitting or being brought into the folds of benefitting from the programmatic capacity building or broadening participation

efforts of the funding agency. The call to change is at the individual beneficiary level, i.e. the three indispensable types of players of the impact team sport, as well as at the institutional level, for academic institutions of all kinds, research institutions, industry and startups, through all research, education, and innovation supporting divisions and offices. The change specifically is from the past habits and practices of engaging with a funding agency in a *'fund and forget'* mode to one in which the funding is allocated with an expectation of impact, and the funding agency, ANRF in this case, operates as a partner, enabler, motivator and assessor of progress towards impact. The call to change deeply resets the tone and *culture* of all beneficiary individuals and institutions, which is a prerequisite for creating the virtuous cycles driving to the endgame discussed in [Section 2](#).

As a partner, enabler, motivator and assessor of progress, a funding agency incorporates the drive to impact at all stages and nature of its engagement with its community and beneficiaries. This includes the proposal review process where a convincing case a proposal makes of the prospect of its impact is critical to its selection for funding. The impact objectives, pathways, and markers established in the impact framework help in aligning what the funding agency seeks and what the proposers can offer through their proposed projects. Following the selection, at all stages of funding through all programs, a guidance framework for mentoring, enabling and assessment supports the objectives of impact-alignment of funded projects. Success of projects in achieving their proposed impact as observed by the relevant impact markers, in full acknowledgement that the markers are signals of evidence about progress, performance, tendency or trend, places the proposers in a favorable state of benefiting from continued or future funding from the agency.

The guidance framework for mentoring, enabling and assessment of projects funded by the funding agency towards staying the course for impact is responsive and designed for efficacy and effectiveness. This implies that it is not 'one size fits all' across all projects funded under all programs. Each funding program is defined by its objectives, as discussed in [Sections III through V](#), and projects funded within a program inherit those objectives and bear a level of complexity by size, collaborative, sectoral features of the project. The key and relevant impact pathways, markers and indicators, as well as the size and duration of funding and the nature of teams funded by each program define the customization of the guidance framework towards mentoring, enabling and assessment of projects. Mentoring and enabling, beyond the funding, is provided by additional resources in terms of expertise and services made available to the project teams, and assessment is by defining the milestones and nature of engagement for assessment, feedback and guidance for continued success of a project.

A key stakeholder of a high-profile marathon, or a relay marathon, are the onlookers and cheerer of the marathon. In the case of government funding for research, development and innovation, these onlookers and cheerers are the various end beneficiaries of the impact of funding. For their benefit, the democratization and demystification of research outcomes is critical. A funding agency makes specific resources available towards this purpose. It is imperative for all funding beneficiaries to utilize these services, such as SARAL AI and all of its features, for generating a variety of content for broad dissemination of research outcomes. Equally critical is the use of social media, webinars and other relevant secondary dissemination channels to demystify and democratize research outcomes. These dissemination activities are captured through various impact markers in [Section IV](#), where operationalization of the markers, such as, altmetric attention score necessitates development of content, use of these channels and assessing the reach they are achieving.

## VI.1. The Impact Scorecard

Beyond the altmetric attention score and other dissemination quantitative, categorical and qualitative markers included in Figures 8 through 10, each project has a set of relevant markers for its research, education and innovation roles aligned with the impact objectives and impact pathways for the ANRF program it is funded by. The collection of these markers can be organized in an *Impact Scorecard*, which will serve as a core artifact for the mentoring, enabling and assessment of projects. During the funding period of a project, based on the milestones and nature of engagement for assessment, feedback and guidance, the Impact Scorecard will provide comprehensive inputs to track and ensure continued success of a project. For some large-scale programs, such as MAHA series, ATRI, PAIR, and also some ARG projects, the Impact Scorecard may be tracked beyond the project funding period.

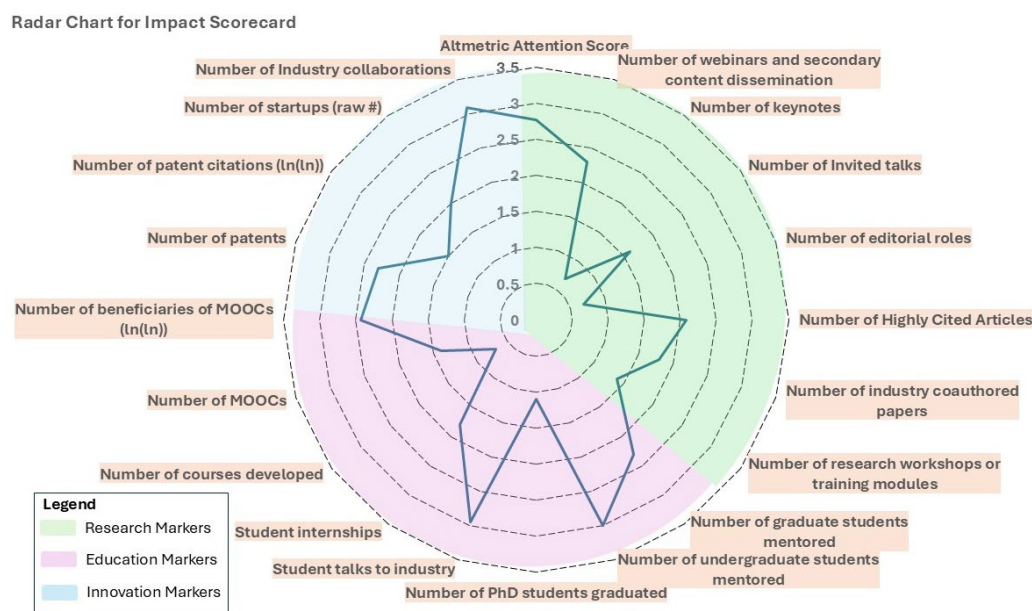


Figure 15: Research, Education, Innovation Sample Impact Markers, Impact Scorecard, and Radar Chart

Figure 15 shows an example status of a project using a radar chart for a sample set of impact markers relevant for the project. All the impact marker levels in the radar chart are in the natural-logarithmic scale, unless otherwise stated next to the impact marker name. The radar chart can

incorporate change in status of the project in terms of these impact markers between milestones by overlaying another radar chart with a different color scheme. The radar chart or a set of radar charts can also be summarized in an Impact Scorecard by the area within the radar enclosure, including specifically for research, education or innovation roles by restricting the area for each color zone in the figure. Similar radar charts and Impact Scorecard inputs can be constructed for relevant categorical impact markers for a project and each of the project's milestones. This would be a direct actionable takeaway based on the impact framework, and each ANRF program's objectives and impact prospects. Finally, AI tools can generate summaries, main highlights and stories from the qualitative markers inputs received for the projects at the assessment milestones.

The Impact Scorecard is an important tool for operationally closing the loop over longer horizons than the funding duration of a project. Closing the loop at these time scales is essential for preventing breaks in the impact pathways, given that generating research breakthroughs and translational unicorns needs long-term, sustained effort. Relay marathon also reflects on how advances in disciplines interlink and how fundamental or use-inspired research progress towards innovation and entrepreneurship. Impactful outcomes at the disciplinary frontiers or boundaries between disciplines can also extend

beyond a project's funding duration. For supporting a seamless relay marathon, new proposals in various ANRF programs would seek the investigator team's past Impact Scorecards for funding received over the last several years.

## **VII. Concluding Remarks and Key Takeaways**

A government funding agency for research, development, and innovation reflects the aspirations of a nation. The aspirations of economic growth, welfare, prosperity, with assurance of safety, security and sovereignty of the nation and productivity of its citizens. We developed an impact framework in this paper starting with first addressing, 'what is impact?' Constructing the answer to that question led to framing the vision of the endgame, followed by working backwards to define the roadmap to realize it.

The impact team sport requires concerted and coordinated effort of all, different types of researchers, industry and startups, academic and research institutions. Most importantly, it needs a change in culture and attitude towards research and governmental research funding. ANRF is a catalyst, but the impact journey is the labor, determination and persistence of relay marathon runners of all walks of research, development, innovation and education enterprise. Besides being a catalyst, ANRF is also a partner, enabler, motivator and assessor of progress towards the endgame.

We conclude with a few aphoristic key takeaway statements to reinforce the message encapsulated in building the impact framework.

- For significant breakthroughs, be aspirational and take risks to address big questions.
- Seek to collaborate and address challenges that push the frontiers of disciplines or boundaries between disciplines.
- Aggressively disseminate research findings to speed up diffusion and create translational prospects.
- Keep students at all levels and the broader society a part of the research and impact journey.
- Research, development and innovation virtuous cycle at all timescales becomes self-propagating and self-sustaining, with high industry engagement.

The current ANRF programmatic portfolio offers many cross-program spillover opportunities. These opportunities are not accidental but rather are constructed intentionally to realize the '*whole being greater than the sum of its parts.*' The spillovers are from fundamental to use-inspired to translational research opportunities, or rising through the TRLs for specific technologies, or collaborating with startup ecosystem or the industry. The spillovers are also from picking the ropes to become research active and expanding into tapping different funding opportunities. Spillovers arise from being exposed to research as an undergraduate student or through exciting research shared on social media leading to pursuing an ambitious research career. Spillover is from earning a doctorate at a foreign university and launching a successful and rewarding research and innovation career in India. As these spillovers and their benefits are realized, ANRF would launch additional new programs to continue growing the expanse and impact of the research, development and innovation virtuous cycles. These virtuous cycles will firmly establish the national science and technology leadership and reputation.

## References:

1. Aksnes, Dag W., Liv Langfeldt, and Paul Wouters. "Citations, citation indicators, and research quality: An overview of basic concepts and theories." *Sage Open* 9.1 (2019): 2158244019829575.
2. Becker, Gary Stanley. "The age of human capital." *Online at [https://www.hoover.org/sites/default/files/uploads/documents/0817928928\\_3.pdf](https://www.hoover.org/sites/default/files/uploads/documents/0817928928_3.pdf)* (2002): 3-8.
3. Bikard, Michaël, and Matt Marx. "Bridging academia and industry: How geographic hubs connect university science and corporate technology." *Management Science* 66.8 (2020): 3425-3443.
4. Bloch, Carter, et al. "Developing a methodology to assess the impact of research grant funding: A mixed methods approach." *Evaluation and program planning* 43 (2014): 105-117.
5. Bornmann, Lutz. "What is societal impact of research and how can it be assessed? A literature survey." *Journal of the American Society for information science and technology* 64.2 (2013): 217-233.
6. Bornmann, Lutz, and Robin Haunschild. "Do altmetrics correlate with the quality of papers? A large-scale empirical study based on F1000Prime data." *PLoS one* 13.5 (2018): e0197133.
7. Bühner, Susanne, et al. "Concepts and methods to measure societal impacts: An overview." (2022). *Fraunhofer ISI Discussion Papers Innovation Systems and Policy Analysis* No. 74
8. Chaddah, Praveen, and Subhash C. Lakhotia. "A policy statement on "Dissemination and evaluation of research output in India," *Indian National Science Academy (New Delhi)*, (2018): 319-329.
9. Combemale, Christophe, et al. "Reconceiving the National Research Enterprise." *Available at SSRN* 5570458 (2025).
10. Corsini, Alberto, and Michele Pezzoni. "Does grant funding foster research impact? Evidence from France." *Journal of Informetrics* 17.4 (2023): 101448.
11. Cremonini, Leon, Edwin Horlings, and Laurens K. Hessels. "Different recipes for the same dish: Comparing policies for scientific excellence across different countries." *Science and public policy* 45.2 (2018): 232-245.
12. Dai, Xin, Jie Tang, and Deyun Yin. "Science and city: Exploring science's contribution to China's urban technological innovation." *China Economic Review* 93 (2025): 102461.
13. Deitz, Steven, and Christina Freyman, Indicators 2024, The State of U.S. Science and Engineering 2024, March 2024, NSB-2024-3
14. Dwivedi, Yogesh K., et al. "'Real impact': Challenges and opportunities in bridging the gap between research and practice—Making a difference in industry, policy, and society." *International Journal of Information Management* 78 (2024): 102750.
15. Fini, Riccardo, et al. "Rethinking the commercialization of public science: From entrepreneurial outcomes to societal impacts." *Academy of Management Perspectives* 32.1 (2018): 4-20.
16. Fleming, Lee. "Breakthroughs and the 'long tail' of innovation." *MIT Sloan Management Review* (2007).
17. Fleming, Lee, et al. "Government-funded research increasingly fuels innovation." *Science* 364.6446 (2019): 1139-1141.
18. Frederiksen, Marianne Harbo, and Mette Præst Knudsen. "From creative ideas to innovation performance: The role of assessment criteria." *Creativity and Innovation Management* 26.1 (2017): 60-74.
19. Frey, Carl Benedikt. "How culture gives the US an innovation edge over China." *MIT Sloan Management Review* 62.3 (2021): 55-61.

20. Higham, Kyle, Gaétan De Rassenfosse, and Adam B. Jaffe. "Patent quality: Towards a systematic framework for analysis and measurement." *Research Policy* 50.4 (2021): 104215.
21. Ibrahim, Hazem, et al. "Citation manipulation through citation mills and pre-print servers." *Scientific Reports* 15.1 (2025): 5480.
22. Kang, Byeongwoo, and Kazuyuki Motohashi. "Academic contribution to industrial innovation by funding type." *Scientometrics* 124.1 (2020): 169-193.
23. National Science Board, National Science Foundation. 2025. Discovery: R&D Activity and Research Publications. Science and Engineering Indicators 2026. NSB-2025-7. Alexandria, VA. Available at <https://nces.nsf.gov/pubs/nsb20257/>.
24. Ou, Guiyan, et al. "Effects of research funding on the academic impact and societal visibility of scientific research." *Journal of Informetrics* 18.4 (2024): 101592.
25. Pertuze, Julio A., et al. "Best practices for industry-university collaboration." *MIT Sloan Management Review* (2010).
26. Quemener, Justin, Luis Miotti, and Abdelghani Maddi. "Technological impact of funded research: A case study of nonpatent references." *Quantitative Science Studies* 5.1 (2024): 170-186.
27. Schneider, Benjamin, Jeffrey Alexander, and Patrick Thomas, Publications Output: U.S. Trends and International Comparisons, NSB-2023-33, December 11, 2023
28. Shueb, Sheikh, and Sumeer Gul. "Measuring the research funding landscape: A case study of BRICS nations." *Global Knowledge, Memory and Communication* 74.1-2 (2025): 346-369.
29. Smit, Jorrit P., and Laurens K. Hessels. "The production of scientific and societal value in research evaluation: a review of societal impact assessment methods." *Research Evaluation* 30.3 (2021): 323-335.
30. Steinfeld, Edward S., and Troels Beltoft. "Innovation lessons from China." *MIT Sloan Management Review* 55.4 (2014): 49.
31. Sugimoto, Cassidy R., et al. "Scholarly use of social media and altmetrics: A review of the literature." *Journal of the association for information science and technology* 68.9 (2017): 2037-2062.
32. Tahamtan, Iman, and Lutz Bornmann. "Altmetrics and societal impact measurements: Match or mismatch? A literature review." *Available online on ResearchGate* (2020).
33. Verhoeven, Dennis, Jurriën Bakker, and Reinhilde Veugelers. "Measuring technological novelty with patent-based indicators." *Research policy* 45.3 (2016): 707-723.
34. Yang, Alex J., et al. "Are disruptive papers more likely to impact technology and society?." *Journal of the Association for Information Science and Technology*, 76.3 (2025): 563-579.
35. Zhu, Tian-Tian, and Wang Chen. "The impact of China's "double world-class" policy on the scientific research outputs of basic disciplines in universities." *International Journal of Educational Research* 128 (2024): 102447.