No. 94 August 2020

RIS Policy Brief

Access, Equity and Inclusion and Science, Technology and Innovation Policy

Introduction

This paper builds on RIS's earlier work on Access, Equity and Inclusion (AEI). [1]

AEI, taken together or separately as norms/values can play an important part in shaping and implementing Science, Technology and Innovation Policy (STIP). They can be integrated in the policy across domains and in strategies. As it will be discussed in this paper, AEI based indicators can be used to measure the outcomes of policies in terms of meeting the basic needs, empowerment, distribution and distributive justice and diversity. Further, AEI as a concept and indicators as tools, can be used to enable and empower the marginalised, gender, differently abled and traditional knowledge holders, to name a few sections of the society. Hence AEI has much relevance in terms of theory and practice. Using AEI in the context of STIP is certainly a novel idea and this can be developed further and can be used in combination with or in the contexts of diversity, gender and distributive justice.

As Inclusive Innovation has become an important idea and practice in many countries including India, it has implications for AEI, and, STIP. In theory Inclusive Innovation is underdeveloped while in practice, it is often represented by programmes and initiatives often without any linkage with larger STIP frameworks. From a AEI perspective it is important to examine Inclusive Innovation and examine whether they promote AEI. In case of emerging technologies like nanotechnology, Artificial Intelligence, literature shows that addressing concerns on AEI is important, particularly to reduce the 'Divides' and to facilitate development of products that fulfil societal needs better. This paper makes a case for including AEI in the policy framework and suggests that AEI can be norms/values that can play more than one role. Indicators for AEI are to be developed further and with such indicators the impacts/outcomes can be measured for AEI. This in turn will make AEI framework a workable framework in policy making, evaluation

RIS *Policy Briefs* are prepared on specific policy issues for the policymakers.

This Policy Brief has been prepared by Dr Ravi K Srinivas, Consultant, RIS. The author acknowledges the guidance and support provided by Prof. Sachin Chaturvedi, Director General, RIS. This paper is part of the inputs being provided by RIS to the Science, Technology and Innovation Policy Process and is first in the series of Policy Briefs/Policy Notes submitted as inputs to the process.

and decision making. It is suggested that incorporating AEI in STIP and strategy will have positive impacts for science and society.

Access, Equity and Inclusion (AEI)

Access, Equity and Inclusion (AEI) are inter-linked although on their own, they individually can be considered as norms/values. But taken together they make a huge difference. Obviously Access and Equity are linked with inclusion and vice-versa. To state that access to benefits of advances in S&T and deriving the benefits of technological progress, to the whole society is obvious. So, prima facie, access is an important value. Equity is a contested term/value but iniquitous distribution of benefits of advances of S&T and/or bearing the disadvantages from developments in S&T without deriving any benefits means that policy is skewed in favour of some sections although that was not intended.[2] Inclusion can be construed to mean that all sections of the society should be beneficiaries or policies should be inclusive enough to ensure that 'no one is left out'. AEI can be used as a norm/value or with proper indicators an assessment tool and as a guiding principle as well for promoting inclusive and sustainable development, particularly in SDGs. (Although it is tempting to bring in the ethical dimension here, it is avoided for reasons of space and not to lose focus on AEI). It can be argued that from an AEI perspective, STIP should ensure that policy framework and associated institutions enhance access, facilitate inclusion and result in more equity in distribution of benefits. It can also be argued that from a larger perspective that, STIP in tandem with other policies should result in inclusive and sustainable development. AEI is closely related to distributive justice.

AEI is central to the debates on access and availability of vaccines, drugs and devices in the context of COVID 19 crisis. Access to vaccines, particularly affordable vaccines is a big issue with no easy solutions in sight. Whether the vaccines will be distributed first to the neediest and countries that are bearing the maximum brunt another issue. This has to do with equitable distribution of the vaccines, medicines and an equitable distribution is not an equal distribution. Whether the vaccines will be distributed in such a way that all countries and all sections of the society are able to benefit from it. This is an issue of inclusion. The inclusivity aspect is crucial in wake of countries trying to negotiate and prioritise their needs over citizens of other countries. Inclusion is an issue if we consider whether vaccine is available to all categories of patients and distribution does not leave any one behind.

The justification for access can be derived from 'Right to Science' which is enshrined in Universal Declaration of Human Rights, which states that everyone has right to '"share in scientific advancement and its benefits'. But Right to science means much than access to benefits or a share in scientific progress and its benefits when it is interpreted broadly. It can in fact inform policy making in public engagement, right to knowledge, right to scientific information and right to be informed. In the Indian context the justification for access can be derived from the expansive interpretations to Article 21 of the Constitution dealing with Right to

[1] Sachin Chaturvedi, Krishna Ravi Srinivas 2015, Science and Technology for Socio-economic Development and Quest for Inclusive Growth: Emerging Evidence from India- Sachin Chaturvedi, Krishna Ravi Srinivas in Science and Technology Governance and Ethics: A Global Perspective from Europe, India and China (Eds) Miltos Ladikas, Sachin Chaturvedi,Yandong Zhao,Dirk Stemerding – Cham, Springer Pp 83-98 http://www.springer.com/gp/book/9783319146928 [Open Access]

Sachin Chaturvedi, Krishna Ravi Srinivas, Rashmi Rastogi 2015, Science, Technology, Innovation in India and Access, Inclusion and Equity: Discourses, Measurement and Emerging Challenges RIS Discussion Paper 202 New Delhi: RIS http://ris.org.in/sites/default/files/pdf/DP202-Prof_Sachin%20Chaturvedi_and_Dr_Ravi_Srinivas.pdf

[2] See Barry Bozeman, Catherine P. Slade, Paul Hirsch 2011, Inequity in the distribution of science and technology outcomes: a conceptual mode, l Policy Sciences , 44, 231–248 (2011). https://doi.org/10.1007/s11077-011-9132-8

Life and in conjunction with a reading of fundamental duties and fundamental rights. When Right to Life does not mean bare existence and right to health and right to education are affirmed by the Supreme Court, the justification for Access is obvious.[3] But irrespective of the legal aspects, access to benefits from science is in fact one of the objectives of STIPs, implied or otherwise. In the Indian context as it has been pointed out in the RIS Discussion Paper, Access dimension of AEI is there in the policy discourse and policies, although it might have been expressed in different words. Access can include access to knowledge/information/education, and access to infrastructure and this is an issue in digital divide as lack of access to information technology infrastructure and related services constrain although there could be access to computers and systems.

To sum up access is a norm that is too important to be left out from the goals/objectives of STIP. STIP in tandem with other policies can address issues in access or lack of it and ensure that all sections of society benefit from scientific and technical progress.

But are the benefits are shared by all equitably or are some sections are left out or benefit a little from S&T. Equity is the norm that is relevant here. Equity and equality are not the same. Equal distribution need not necessarily result in an outcome that is equitable and may exacerbate inequalities. Inclusion and equity can complement each other but not always. Because when included, in the name of inclusion, groups/individuals, who are better off or with better access to resources, may derive more benefits, leaving those whose needs should have been served better.

In the recent years, the importance of E&I in policy making has increased on account of factors like countries promoting inclusive growth or inclusive development by harnessing S&T as a part of the strategy, the realization that there could be new divides when new technologies are adopted and the understanding that at times S&T policies may end up in increasing inequity. Moreover, the innovation discourse and practice today are sensitive to the needs of the marginalized, women and those who are left out of the economic growth process. Often diversity, inclusion, access are associated with equity, so that they together constitute norms or guiding principles. Equity and Inclusion can be additional values/principles to access and diversity.

S&T and I policy can focus on addressing the inequities and ensure that new policies do not create new inequities or exacerbate existing ones. However, the challenge lies in ensuring that there is a policy coherence in addressing this and even if other policies exacerbate, S&T and I policy has a neutral impact or promotes equity. For example, S&T and I policy can focus on providing basic needs or enable marginalised sections to have better access to them or deploy technologies to bridge the divides. S&T policy can address issues in equity through various means ranging from provision of cheaper and effective devices, affordable drugs/treatment, incentivising production and distribution of products and services that enhance equity. Yet we need to understand that on account of developments in technology and other

[3] For reasons of space we do not discuss this in detail. See Jessica M.Wyndham, Margaret Weigers Vitullo 'Define the human right to science' SCIENCE 30 NOV 2018 : 975

factors, the policies to address issues in equity have to be dynamic and agile. S&T policies in combination with other policies can promote equity oriented outcomes by combining different aspects, ranging from subsidies, tax benefits, to preferential policies and prioritization.

Inclusion is different from diversity. As Science and Technology (S&T) can be a cause for inequality and exclusion, it is important to ensure that inclusion is taken as a norm/value in evaluating impact of S&T and I policies. Inclusion can be an objective of STIP. Inclusion is now part of the development lexicon with inclusive growth and social inclusion are now part of the development policies. One reason is the realisation that economic growth often leaves out some sections or exacerbates the overall inequality in society and further marginalisation of some. In this regard what is the role of science and technology depends on how technology contributes to this marginalisation or whether it is the cause for marginalisation. Discussing inequality and technology a publication from UNESCAP points out

"Policymakers seeking to ensure that technology contributes to, rather than undermines, equality face challenging questions: What role has technology played in creating and addressing inequality, in terms of income, opportunity and environmental impact in Asia and the Pacific? How will future technologies potentially reshape trends in inequalities in the region?" (P 64)[4]

It discusses the relationship between three types of inequalities, viz. inequality of outcome, inequality of opportunity and inequality of impact and states: "Inclusive technology and innovation policies can help address inequalities. While the market is a key determinant of technology development, governments have influence in the direction of technology change."[5]

One way to address the question of exclusion and inequality is to have specific policies and programmes that address the specific needs of the excluded groups or enhance inclusion through specific technological interventions. The emphasis on financial inclusion is driven by technology-based solutions and this has worked well. On the other hand, as the report points out policy makers should pay attention to the three types of inequalities, besides the 'divides' and impacts of new technologies on inclusion and exclusion, particularly in case of technologies that can result in loss of jobs, reduction in employment and worsen the various 'divides'.

it is necessary to point out that the concept of Access, Equity and Inclusion should not be stretched to a meaningless mumbo-jumbo or promoted as a panacea. This is very important because promoting AEI are essential, but often not sufficient when there are structural inequities and other factors that inhibit development of capabilities and capacities. Thus, in addressing gender issues, AEI are important but we need to pay attention to diversity as well on one hand, and, the host of factors that individually or in combination result in denial of equality in opportunities, rights and entitlements.[6]

Thus, policies that promote AEI cannot be panaceas or sufficient enough to address all inequities or inequalities. On the other hand, a combination of policies that include STIP can play a

[4] UNESCAP 2018 Inequality in Asia and Pacific in the Era of Sustainable Development Bangkok: UNESCAP P64

[5] Ibid P93

[6] Some of these will be discussed in a forthcoming paper in this series

major difference. Thus, policy coherence and synergy are critical. DST and other government departments and agencies have programmes that are tailored to address AEI aspect. For example, the SEED at DST and programmes like KIRAN. Similarly, there are initiatives and programmes to facilitate financial inclusion through technology (e.g. JAM trio). For reasons of space and other factors a discussion on them is not given here. We acknowledge their positive contribution in enhancing AEI in practice.

It is worth pointing out that AEI concept or framework does acknowledge the fact that technology can be an equalizer too. Technological leapfrogging has been useful in addressing many issues in Access, Equity and Inclusion and technology can mitigate some constraints imposed by other factors, besides ensuring that there is overall progress in Society.[7]

Inclusive Innovation

In the literature and in policy discourse in recent decade or so, Inclusive Innovation has gained much traction and is also promoted as a solution to enhance AEI as well to deploy technologies at the appropriate scale and in the appropriate context. Still, we need to consider the tension in theory and practice in using Inclusive Innovation. For example, the concept of inclusive innovation does not mean that there is a single understanding or consensus around that term but it encompasses a variety of contested.[8] Heeks, et.al have identified the issues with Inclusive Innovation in theory and practice.[9]

To give an example an inclusive innovation for differently abled while empowering some of the disabled, it may not be accessible/affordable to all those who need it/deserve it. Here the principle of AEI if applied will indicate that the outcome need not result in equity even when the innovation is claimed to be inclusive. This is not just an issue of cost or access, there could be other issues ranging from design to adoption by user. On the other hand, such an innovation is inclusive in another sense as it benefits some of those who otherwise had no access to this enabling/empowering technology. Hence it is better to pay attention to the deployment and use of Inclusive Innovation than to be misled by the name.

In the literature equity and the three concepts of equity (political equity, equality of opportunity and basic needs) have been addressed in the context of different issues such as digital divide or objectives such as need to increase access to affordable health. It can be good solution to address the last category and basic needs. But as of now we have no well-defined indicators for inclusive innovation.

On the other hand, as Rajeswari Raina points out, it is not just an issue of adding inclusion and stir and according to her, "If inclusion of heretofore neglected spaces, people and knowledge in development does matter, then the capacities of people and organizations in the processes of production, distribution and consumption – or innovation capacities in all economic processes matter too"[10]

The recent emphasis on inclusive innovation is on account of the realisation that inclusive innovation policies and

[7] Sachin Chaturvedi 2020 Social and Economic Inequalities: Would Technology be the New Equaliser? Atal Bihari Vajpayee Memorial Lecture 20th Annual Conference of the Indian Association of Social Science Institutions, ISEC, Bangalore, 27th February, 2020

[8] Mario Pansera ,Richard Owen 2018 Framing inclusive innovation within the discourse of development: insights from case studies in India , Research Policy, vol. 47, No. 1 (February 2018), pp. 23–34

[9] Richard Heeks et.al 2013 Inclusive Innovation: Definition, Conceptualisation and Future Research Priorities, Paper No 53, Institute for Development Policy and Management, SEED University of Manchester, Manchester

[10] Rajeswari R.Raina 2009, Conceptual challenges for socially inclusive innovation in India's drylands http://www.prolinnova.net/iaps/media/1.%20Raina%20-%20conceptual%20challenges%20for%20inclusive%20innovation%20-%20for%20web.pdf. See also Rajeswari Raina, Keshab Das (Editors) 2020, Inclusive Innovation Evidence and Options in Rural India Cham: Springer

programmes delivers and meet needs which have been either unaddressed or poorly addressed. Inclusive Innovation in one sense is also used as a catch all phrase to categorise all sorts of innovation across sectors, across different categories of users and for all needs. The lack of clarity in Inclusive Innovation coupled with lack of indicators makes a realistic assessment of impacts of Inclusive Innovation difficult. Inclusive Innovations can promote AEI and it can also be argued that innovations that promote or facilitate, i.e. inclusion can be categorised as Inclusive Innovation. This is acceptable. But whether all Inclusive Innovations will also promote equity is not clear. Because the case studies and the literature do not address this dimension directly while their foci have been on access and inclusion.

In our view Inclusive Innovation is a relevant concept and practice but we need more work in theory and practice. The main point is that the promotion of Inclusive Innovation as an attractive solution, often through case studies seems to have resulted in a naïve faith about Inclusive Innovation and thinking that it is an excellent tool to empower, enhance access and promote technology based developmental choices, without any issues.

From a policy perspective individual case studies are necessary but not sufficient to consider Inclusive Innovation as a primary policy tool to address all problems related to Inclusion or AEI or for that matter to meet development objectives. On the other hand, a study by UNESCAP raises serious questions that cannot be glossed over. These questions are relevant for India also.[11]

AEI and Emerging Technologies

In wake of the enormous implications of Emerging Technologies, in the last decade much research has been on the equity implications of them and such research has also been on community equity, access to treatments, inclusion in research and equitable sharing of the innovation. By now there is substantial literature on AEI or one of the components and emerging technologies, and these studies indicate equity and other dimensions have to be taken into account in technology development, deployment, planning and, application and how policies can facilitate more inclusion or access.[12]

For reasons of space we highlight few recent studies that have taken into account AEI in assessing emerging technologies/applications.

- Exoskeletons are wearable devices and are placed on the user's body. They act as amplifiers and thus can "augment, reinforce or restore human performance" by working with the user. They are the result of applying robotics and biomechatronics to augment the performance of users in doing a variety of tasks. As the technology is evolving a precise definition is not possible at this stage.[13] They can be considered as robotic suits. Besides differently abled and those undergoing treatment they can be used by construction workers as well. Since the technology is new and is evolving, in future it could be made relevant for more categories of users.

  Taking Exoskeleton and its users as a case study after assessing the available models of exoskeletons,

[11] UNESCAP 2018, Mainstreaming inclusive technology and innovation policies that leave no one behind, ESCAP/CICTSTI/2018/6, Economic and Social Commission for Asia and the Pacific Committee on Information and Communications Technology, Science, Technology and Innovation Second session, Bangkok, 29–31 August 2018

For example Yujie Guo et.al 2018 Equity Assessment for Emerging Transportation Technologies: A Comprehensive Literature Review and Case Study , Center for Transportation, Environment, and Community Health, Cornell University, Ithaca

Jacqueline Kuzio 2019, Planning for Social Equity and Emerging Technologies, Transportation Research Record, 1–11 DOI: 10.1177/0361198119852065

Clara C. Hildebrandt, Jonathan M. Marron, 2018 Justice in CRISPR/Cas9 Research and Clinical Applications, AMA Journal of Ethics® September 2018, Volume 20, Number 9: E826-833

Matthew Harsh, et.al 2018 The role of emerging technologies in inclusive innovation: the case of nanotechnology in South Africa, Science and Public Policy, 45(5), 2018, 597–607

For reasons of space we have given only a few examples

[13] https://exoskeletonreport.com/what-is-an-exoskeleton/

Roger Andre Søraa and Eduard Fosch-Villaronga state, "By integrating a deeper understanding of how users of exoskeleton come in a wide variety of attributes, shapes, sizes, gender, and wealth, and that there is no general "one-size fits all." Exoskeleton technology holds the potential for being more inclusive. To make this technology available for all who need it, designers and producers must also think beyond their target market… Some potential solutions could be to give incentives for technology producers to also include users who do not fit the standard frames of the technology, thus realizing and providing "exoskeletons for all."[14] (P225-226.)

- After studying Nanotechnology in Canada and the equity challenges Gita Ghiasi Hafezi states

  "The findings reveal that only a narrow spectrum of Canadian nanotechnology articles and patents reflect pro-poor priorities, and acknowledge the importance of promoting and leading research and innovation in pro-poor areas, as it holds the potential to promote the economic development both within and between nations. However, these pro-poor scientific and innovative efforts tend to be highly male-dominated in terms of the scientific community and the workforce involved." Her study looks at the gender dimension as well and points out the exclusion/ underrepresentation of women.[15]

- In a case study on 3D Printing in Brazil, Woodson et.al point out that although there is enough potential to consider that as an inclusive innovation, there are barriers and this includes lack of access to 3D printers.[16]

Thus, in the literature and policy discourse Inclusion and Equity are taken into account when assessing the impacts of emerging technologies or plans involving them for mobility and transportation. In case of Artificial Intelligence the debate and discourse on impacts often takes into account inclusion and access dimension on one hand, and, the ethics and responsibility dimension, on the other hand.[17] Similarly in case of Robotics there is an emerging engagement on inclusion and inclusivity.[18]

Thus, there is enough scope to use AEI in assessing the impacts of emerging technology and in governing them. How to do these is beyond the scope of this paper. Still we want to point out that India can benefit much from the discourse and policy initiatives on emerging technologies that give importance to AEI. As these technologies are in early stages in India, this is the right time to bring in AEI aspects and dimension in research, funding, education and other related activities. This will also ensure that they are socially ready and more acceptable to society. Given the issues like lack of trust and anxieties about inherent biases in applying AI, AEI should be used creatively to address them. Hence, we see a greater scope for AEI in emerging technologies. In the Indian context we need studies on AEI and emerging technologies. Doing them now is more relevant as they are in initial stages.

[14] Roger Andre Søraa, Eduard Fosch-Villaronga, 2020 Exoskeletons for all: The interplay between exoskeletons, inclusion, gender, and intersectionality, Paladyn, Journal of Behavioral Robotics 2020; 11: 217–227

[15] Gita Ghiasi Hafezi 2018, Canadian Nanotechnology and Equity Challenges: Implications for Pro-Poor and Gender-Inclusive Policy, PhD Thesis, Concordia University Montreal, Quebec,

[16] Thomas Woodson, et.al 2019, Is 3D printing an inclusive innovation?: An examination of 3D printing in Brazil , Technovation Volumes 80–81, February–March 2019, Pages 54-62

[17] https://www.media.mit.edu/projects/ai-and-inclusion/overview/

[18] http://inbots.eu/

AEI and Research Funding and Evaluation

It is important concerns relating to AEI are brought in at the early stage, i.e. research proposal stage so that research project is sensitive to AEI in the initial stages itself. One way to go about it is to use it in project/proposal evaluation.

Although AEI is not specifically used by National Science Foundation, it does talk of broader impacts, "Every NSF grant has the potential to not only advance knowledge, but benefit society -- what we call broader impacts. Just like the kaleidoscopic nature of science, broader impacts come in many forms. No matter the method, however, broader impacts ensure all NSF-funded science works to better our world."[19]

In the Indian context AEI can be directly or indirectly made part of Research Funding and evaluation of projects/proposals with guidelines on using AEI. In fact, in case of proposals relating to some sections like women, traditional knowledge holders and differently abled the proposals can specifically look into AEI aspects and whether they enhance Access, promote equitable realisation of outcomes, and, the design/outcomes are inclusive. For example, a proposal on Assistive Technologies can be evaluated by using AEI as a criterion. If the proposal is on developing a tool or device or equipment to help the differently abled, then whether the innovation that will be the outcome be accessible to different categories among differently abled, whether it will result in a equitable outcome and whether it is inclusive or facilitate their inclusion, can be some of the questions that stem from a AEI perspective. To give an example, access is linked to affordability and hence whether the innovation will be affordable can be a question. It can be argued that it is premature to ask this question at the initial stages. Still, if the proposal factors affordability then one of the objectives will be to design an affordable innovation that enhances access, not just an innovation that is useful.

Similarly, whether innovation can be made inclusive can be examined. In the earlier section on AEI and Emerging Technologies we have referred to a study on exoskeletons and pointed out how the study used inclusion and gender as criterion to assess the innovation and pointed out how the innovation could be made more inclusive. According to that study there are 'inclusive design choices' and it is suggested under inclusivity considerations

"Think about the importance of including typically marginalised communities such as the LGBTQ+ in the development of technology to avoid discrimination and reinforcing the existing biases. Be inclusive-by-design and remember that any inclusion criteria may represent exclusion criteria for other communities. Careful reflection on these aspects when developing technology – including exoskeletons – can benefit both society and the individual". (P 225)[20]

Similarly, on affordable access they state, "Although there may be many exoskeleton solutions out in the market, their use largely remains limited to the rehabilitation center or wealthy patients… In more egalitarian societies like the Nordic European countries, it is the state's responsibility to provide good minimal equal health care for all citizens. However, exoskeletons currently are not

[19] https://www.nsf.gov/od/oia/special/broaderimpacts/

[20] Roger Andre Søraa, Eduard Fosch-Villaronga, 2020 Exoskeletons for all: The interplay between exoskeletons, inclusion, gender, and intersectionality, Paladyn, Journal of Behavioral Robotics 2020; 11: 217–227

seen as "necessary enough" for patients to have their own, due primarily to the high cost of the technology. Also, there is little evidence on the social impact of using the technology." (P223)[21]

Such an analysis of an emerging technological application indicates that while the technological application has much potential, that could be limited if it is less accessible and less inclusive. While design is a part of the problem, that is not the only issue. Now if DST were to assess a proposal on using of robotics to develop an assistive device for the elderly or differently abled and if it could use the criteria of AEI to assess the proposal in the initial stages itself some issues will become evident and addressing them can make the innovation more accessible, affordable and equitably available to the users.

It is not necessary that such an assessment can be made only in the initial or review of proposal stages. Even for innovations that are outcomes of supported or funded projects/programs such an assessment can be made when the innovation is ready for testing and later if successful in testing for adoption/commercialisation. By looking into issues like affordable access and inclusivity, the funding agency, i.e. Department of Science and Technology (DST) can ensure that the innovation meets the societal needs effectively and has wider positive impacts.

For reasons of space we are not elaborating the application of AEI in funding, etc. It is sufficient to state at this stage that using AEI by funding agencies such as DST will make a real difference in developing innovative solutions for better utilization and application of Science and Technology.

AEI and Indicators

A major issue with AEI is lack of indicators and lack of clarity on necessary data and lack of methodologies. The Discussion Paper published in 2014 addressed this through a data set and a methodology and their limitation was acknowledged. As that is the first paper on AEI and methodology to measure AEI, we had made some preliminary observations based on the results of the analysis.

The need for indicators to give a quantitative dimension to AEI is obvious. But if AEI has to play an important role, it needs a sound theory and solid/robust methodology. In such a case the theory can be made better from application of methodology and the quantitative dimension will be more meaningful in light of a sophisticated theory.

The theoretical discussion in this paper and the earlier should be developed further. Access, Equity and Inclusion should be developed further in terms of richness in theory, strength in conceptual foundation and utility as an analytical category. Moreover, we need good if not precise definitions for terms used. As pointed out in the case of Inclusive Innovation, otherwise there will not be clarity and this will limit its practical relevance.

As it has been pointed there are similar issues with Inclusive Innovation also. Thus, it makes sense to develop methodologies, and indicators to use AEI framework more effectively. A group of scholars can be formed to work further on this, while another can work on similar issues in Inclusive Innovation. Both groups together then develop relevant methodologies and indicators besides

[21] Ibid

identifying the components of data to be collected and assessed. In our view, such an exercise can be funded by the DST. As much is in common between AEI and Inclusive Innovation such an exercise will be relevant for other countries as well.

Conclusion

Our analysis shows AEI has significant implications for STIP. AEI can be used as a norm/value and will have multiple uses in science policy and practice. It can be used at different stages of R&D and in large research projects, besides evaluating innovation. Although it can be used in conjunction with Technology Assessment, this is not discussed here in detail. So is the linkage between AEI and Responsible Research and Innovation (RRI) is not discussed here. It is not the intention to state that AEI is a panacea or a tool for all purposes or objectives. In theory and practice AEI can be advanced and given its relevance and ramifications for policy making and practice it deserves a serious consideration.

Policy Recommendations

- STIP should consider AEI as a norm/value/principle that has an overarching role and place in policy making and practice. As AEI is closely related to impacts on society, distribution of benefits and social value of S&TI, STIP and other policy instruments can explicitly acknowledge its relevance and adoption in policy making and practice. DST has many programmes that are directly or indirectly related to AEI such as KIRAN. Hence it is suggested that DST can use AEI effectively to enhance their reach and impact, and, in assessing them, besides in expanding or reorganising them. A detailed exposition of this idea is beyond the scope of this Policy Brief.
- In each major R&D institution or research university or DST/CSIR centres there should be an office or cell to address issues on AEI and this cell can perform multiple roles.
- As mentioned elsewhere, it can be incorporated in research funding, not just in preliminary stage of evaluation but also in assessing the impacts or benefits of innovations to society. In this regard it is suggested:
  - » Indicate in call for proposals or in proposal related documents and forms that AEI can be a criterion to assess.
  - » Ask the proposers to state how their proposal or innovation will result in better outcomes in terms of AEI. They can also indicate how they are addressing the AEI aspects in the proposal.
  - » Develop a methodology, and, framework on using AEI in proposal evaluation and in assessing innovations.
  - » AEI can be used to assess the outcomes of projects/programs and to evaluate innovations. One approach is that although AEI was not part of the criterion initially used, it can be used now to see whether the innovation is accessible and if not how to make it accessible. The AEI aspect can be addressed in many ways ranging from changes in design to

    increasing the categories of applications, from taking into account users perspectives to

addressing special needs of some categories of users.

- Using AEI as a criterion or factor will also result in enhanced use or adoption, resulting in wider diffusion and greater social benefit. For example, if it is found that an innovation is technologically sound and is effective but cannot be adopted well on account of high cost or factors related to inclusivity, these can be addressed in many ways, ranging from subsidies to additional funding to develop it further to make it more inclusive. The equity aspect in this also important.

  Whether to use AEI in addition to other criteria as an add on or should AEI be an integral part of evaluation or assessment is a question. Our suggestion is that it should be an integral part, not as an additional or add on factor. Such an approach will also help in enhancing the public value of Science and make Science and Technology more relevant and oriented towards societal needs.

- AEI is particularly useful in developing programmes for the marginalised, women and differently abled, to name a few and in assessing programmes meant for them. Here as we will point out in another paper AEI can be combined with another approach to enhance the use of AEI, on one hand, and to make the programs meant for those sections more effective, meaningful and relevant. For example, a program on enhancing women's participation in Science and Technology can use the inclusivity aspect to see as to whether the program is really inclusive for all categories of women or whether by design or by criterion if leaves out some, unintentionally. Similarly, the outcomes of such programmes can be measured by assessing whether they can contribute to or enhance equity and whether benefits are shared or used equitably. Here Access can play a key tool is not just evaluation but also in formulation.

- AEI has implications for other policies and programmes of different departments/ministries that use science and technology. Thus, it can be used by departments such as Health and Family Welfare, Depart of Health Research, to mention a few.

- AEI can be made part of Research Ethics frameworks and in evaluating the ethical aspects and implications of research proposals and outcomes. For reasons of space we are not elaborating it further.

- As pointed out AEI has special relevance for emerging technologies. As DST and other Ministries/ Departments have programmes/ initiatives on emerging technologies, using AEI from the beginning will make them more relevant and can result in socially desirable and better outcome. Obviously, this has to be discussed taking into account the specificities involved. As we have shown there are examples of using AEI or one or two among the three in assessing the impact of emerging technologies/applications and some programmes/sectors have been assessed on using AEI or one among them. Hence we suggest that DST should set up a committee or working group on AEI and emerging technologies to study this idea further and come up with suggestions.

- AEI can be used in conjunction with Technology Assessment (TA) and has relevance for Scientific Social Responsibility (SSR). These aspects will be elaborated later. At this stage it will suffice to state that in case of SSR, the AEI aspect/dimension has significance for adoption of SSR and its impacts on society.
- Given the emphasis on Inclusive Innovation and similar approaches or models, use of AEI in assessing them and in conceptualising Inclusive Innovation will enhance the development of Inclusive Innovation in theory and practice. Hence DST and other agencies should adopt AEI in their support to Inclusive Innovation.
- It is not necessary that AEI should be used only by Government Agencies or Departments. It has wider relevance and particularly for private sector, research organisations using funding from multiple sources and for civil society. DST can play a role in realising this relevance. For example, it can use it in its work with civil society to assess their programmes and also in Public-Private Partnerships.
- As we have pointed out AEI is an emerging concept and there are issues relating to development of indicators, collection and use of data and much more work is to be done in both theory and developing frameworks and methodologies. DST should support such work.

Finally, it is suggested that DST should support AEI in a significant manner and some suggestions have been outlined in this section. A beginning can be made by forming a Working Group on AEI by DST and office of Principal Scientific Advisor so that the concept and its application can be taken forward.

As this is a very novel concept and not much work is done in India or elsewhere on different aspects of AEI in a wholistic manner. So, setting such a Working Group will be a major contribution to science-society linkage and will strengthen efforts to, inter alia, make fruits of S&T more accessible and affordable. This will be relevant for STIP and its implementation. Globally it will enable India to lead forward in developing and deploying a novel, policy and practice relevant concept.

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