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Impact of Indian Science Academies: A Community Perspective

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Abstract

Science academies form an integral part of national innovation systems. They play multiple, direct and indirect roles in the development of scientific and technological capabilities. This paper proposes a conceptual framework of the functions of science academies using the technology community framework. The framework is empirically tested by examining the impact of the functions of Indian Science Academies. The three most important areas that science academies need to address are in the areas of publications, forming networks with other organizations, and leveraging their position to have an impact on science and technology policy.

Keywords: Science Academies, Science societies, technology community.

Introduction

National Innovation Systems (NIS) has emerged as a dominant macro level paradigm employed by economists and policy analysts to evaluate and explain differences in capability building and innovation among different countries. NIS is posited to affect both the rate and direction of social technological change in the country [1]. It includes both 'things that pattern behaviour' like norms, rule and laws (such as patent systems and technical standard) and 'formal structure with an explicit purpose' such as firms, industrial R&D laboratories, universities and public R&D institutes [2]. Niosi et al [3] define NIS as " the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction between these units may be technical, commercial, legal, social and financial, in as much as the goal of the interaction is the development, protection, financing, or regulation of new science and technology."

Scientific and technology academies form a very significant part of national innovation system, often co-evolving with NIS itself. Science academies are non-profit bodies that play an important role in the development and diffusion of scientific knowledge and technology in a country. They form an important not-for-profit sub-system within the innovation system that facilitates the development and commercialisation of new technologies and serves to promote economic growth in a country. They serve multiple purposes: a) as apex bodies responsible for promoting a scientific culture in the country; b) support national science and technology policy making; c) establish linkages with similar organizations both within and outside the country to provide mutual assistance, information sources, opportunities for exchange, cooperation, and joint research; d) provide a fraternity to researchers that serves to promote professional and social networking and collaboration; and e) help create a vibrant platform for academy-industry interaction. They promote mimetic, coercive and normative isomorphism by serving as platforms for sharing of information and knowledge, thus contributing to transfer of best practices and approaches [4]. They liaison with other national and international organizations and academies. These expert exchanges have becomes all the more important in the context of the emergence of knowledge driven industries.

Research on national innovation systems has hinted on the functions of science and technology associations and academies but there has been no elaboration on how they impact the development of science and technology in a country [5]. Sigurdson [6] was one of the few studies we could identify that specifically dealt with the role of Engineering Research Associations in the context of Japan. Our understanding of contributions of the scientific academies to the capability building and development is lacking, more so in the context of developing countries such as India, where these academies have to undertake capability building in a resource constrained and catching-up environment. This paper attempts to fill this gap. The paper presents a conceptual model of the functions of science academies based on the technology community framework proposed by Van de Ven [7]. We then empirically analyse the impact of these functions in the context of Indian Science Academies. Discussions and implications follow.

Conceptual framework

From a social science perspective, science academies can be seen as a community of scientists interlinked with other institutions embedded in an ecology of organizations. Communities and collaborations in science have long been of interest to the sociologists [8,9]. Traweek [10] examining the world of high-energy physics, of which she wrote that it is "a culture of no culture, which longs passionately for a world without loose ends, without temperament, gender, nationalism, or other sources of discord for a world outside human space and time". Fleck [11] defines thought collectives as 'a community of persons mutually exchanging ideas or maintaining intellectual interaction.' It also 'provides the special "carrier" for the historical development of any field of thought, as well as for the given stock of knowledge and level of culture.' From this perspective, science academies can be construed as meso-thought collectives.

A review of the sociology literature reveals at least three core elements of community [12]. The first and most important element of community is what Gusfield [13] refers to as consciousness of kind. Consciousness of kind is the intrinsic connection that members feel towards one another, and the collective sense of difference from others not in the community. Consciousness of kind is shared consciousness, a way of thinking about things that is more than shared attitudes or perceived similarity. It is a shared knowing of belonging [14]. The second element of community is the presence of shared rituals and traditions. Rituals and traditions perpetuate the community's shared history, culture, and consciousness. Rituals "serve to contain the drift of meanings; . . . [they] are conventions that set up visible public definitions" [15] and social solidarity [16]. The third element of community is a sense of moral responsibility, which is a felt sense of duty or obligation to the community as a whole, and to its individual members. This sense of moral responsibility is what produces, in times of threat to the community, collective action. Science academies fulfil all of the above conditions. Prospective members are nominated by incumbent members, and therefore like other communities, shared consciousness, rituals and traditions, and sense of moral responsibility mark science academies. Membership of the academy provides a sense of connectivity and community. Annual conferences, and rituals of selection and initiation of new fellows give a sense of shared rituals and traditions. Finally, the sense of moral responsibility towards the community is manifested by voluntary participation of members in various functions of the academy.

Niosi [17] construes NIS as a set of interrelated institutions consisting of knowledge, finance, human, regulatory and commercial flows. We believe that science academies contribute directly to knowledge and human flows and indirectly to regulatory flows. They contribute to knowledge flows by promoting and disseminating science and science education, and through various forums for presentation and publication of research. They contribute to human flows by establishing linkages with other similar bodies across the world and facilitating exchanges and collaborations. They contribute to regulatory flows by serving on national and international committees involved in policymaking and standard setting.

In a broader sense, scientific academies may be seen as community of practice with a group of people working and interacting in related bodies of scientific knowledge [18]. Science academies are generic in nature with primary interest in sciences and their philosophical underpinnings. On the other hand, technology academies are often focused on application of a particular stream of technical knowledge across industries. In comparison to science academies, science societies can be seen as specialized communities of practice focusing on a particular discipline or sub-discipline of science to provide a structured platform of professional and social relationships with the objective of advancing that particular area of science. For example, divergent groups such as physical chemistry association, organic metallurgy society and bio-chemical society that are specific areas of application of natural sciences with unique methodological approaches and paradigms.

Science academies are formalized institutions sanctified by legislation, receive financial support from their respective national governments and are recognized by international agencies and partners as the legitimate facilitators of human resource and information exchange. Academies elect their members from among the accomplished scientists and technologies from their respective communities of practice. Science academies are non-profit organizations that work outside the framework of government providing independent advice on matters of science and technology. They usually function through committees that include nation's top scientists, engineers, and other experts – all of whom volunteer their time to study specific concerns. The results of their deliberations have the possibility of having significant and lasting impact on science and technology in a country. For example, National Academy of Sciences, U.S.A was established in 1863, during the Civil War. The federal government funded the Academy but not the members affiliated with it who had "an obligation to investigate, examine, experiment, and report upon any subject of science or art in response to a request from any department of the Government" [19].

On the lines of Tushman and Rosenkopf [20], scientific and technology academies can be construed as a set of organization that brings together all the stakeholders with an interest in pursuing scientific and technological development and institutionalisation of scientific knowledge. Scientific academies often play an indirect role in development of national innovation system's capability. They serve as nodes connecting multiple scientific and technological institutions, forum that aid in setting national priorities, developing appropriate scientific culture, and representing all stakeholders to project a unified front concerning national and international science issues. Social constructivist theory argues that learning is a social process of acculturation into an established community of practice [21]. Within this social process, learning takes place when it is sustained, experimented, collaborated and connected with other members. Knowing, doing and belonging thus form inseparable stages of knowledge generation and diffusion in communities. Scientific academies act as a mediator in increasing professional and social interactions, and facilitate formations of networks amongst the community.

Science academies serve as platforms promoting a practice or an approach that could lead to incremental and radical innovations in the NIS. Science academies get involved in sustaining long-term basic research, linking it to societal goals, and coupling global, national, and local institutions into an effective research system linking academia, government, and the private sector in collaborative research partnerships. One of their main contributions is to help provide a continued assessment of the effectiveness of learning from diverse educational experiences. Science is often not taught in an exciting and effective way that sparks a desire in students to pursue careers in science or give them the ability to think analytically or to continue their learning throughout their lives. The scientific and technological academies engage themselves as active partners with the educational system to ensure inclusion of exciting and effective, quality science education at all levels.

Adopting Van de Ven [7] and Rusinko and Mathews [22] technology community framework to scientific academies, we propose that science academies contribute to development of science and technological capability by adopting resource endowments, recognition and linkages, and institutionalisation functions. As communities of practice, scientific and technology academies play a very crucial role in developing scientific temperament, training and extending the knowledge base, and enhancing the viability of an innovation by signalling and supporting legislation, regulation and standardization efforts. These functions need to be seen from a systems perspective as they are interdependent and mutually reinforce each other either by influencing one another or by co-producing one another [7]. Hence, they could produce positive actions with other states. From network externalities perspective, larger the number of trained and recognized members of a group, the larger would be the group's ability to influence national and international policy regimes, standard setting, governments and society in general. All three set of functions help an academy to more effectively manage resources, achieve operational goals and meet its member's expectations.

Resource endowment functions underlie creation of resources, platforms for member and membership development, and information exchange. Resource endowments functions include a) promotion of local scientific efforts and scientists, and b) secure and manage funds and endowments for promotion of science.

Scientific academies pursue recognition and linkage functions with an aim to develop a social consensus of desirable quality and integrity of scientific research and its diffusion. One of these is the need for affirmation. Creative and intellectual activities are motivated and sustained along a variety of dimensions. The hard effort involved in sustained, productive work requires a sense of trust in oneself. The ability to develop such a sense is nourished and sustained in certain effective recognition systems. Recognition functions include a) institute and establish professorships, fellowships, scholarships, and other awards, and b) recognize and reward scientists and scientific talent. Another important dimension of recognition of work is linked to developments in one's domain of endeavour. This is facilitated by the linkage function performed by the academies. When scientists are engaged in re-examining theories that are in conflict with new discoveries, insights, or perspectives, they find "thinking together" particularly productive. Academies by providing a platform for collaborative thinking to emerge prevail in the construction of a new framework. In this way, researchers overcome the grip of a dominant perspective [23]. Linkage functions include a) promotion and dissemination of science and science education in pure and applied form, b) to provide a forum for publications of research, c) organize meetings, symposiums, conferences which provide a forum for presentation and discussion of research and science, and d) establish linkages, collaboration and coordination among other local scientific academies, science institutes, government scientific departments and industry within the country and abroad.

Science academies also pursue institutionalisation functions that can primarily be of two kinds. One kind of institutionalisation function enshrines the academy with legal powers to set standards, and confer and regulate their fellows, while the other kind of institutionalisation function is more recommendatory in nature. Scientific academies get involved in standard setting, policy formation and development of networks of national and international linkages. Specifically science academies a) participate in national committees influencing science and technology policies, b) participate in international science and technology committees, c) take up issues of concern to the scientific community with the relevant authorities in the country, d) take up issues related to the role of science in the areas of social responsibility, ethics, human rights, and individual freedom, and e) participate and influence national and international standard setting. The above framework is presented in Figure 1. In the next section, we apply the above framework to analyse the impact of Indian science academies.

Methodology

Sample

India has three main science academies, namely, Indian National Science Academy (INSA) located in Delhi and considered as the apex science academy of India, Indian Academy of Sciences (IAS) located in Allahabad, and National Academy of Science (NAS) located in Bangalore. Table 1 provides the details of these academies. We interviewed office-bearers and members these academies to develop an understanding of the founding goals, mission and vision of the organization, evolutionary changes, current focus and functions, challenges in knowledge development and diffusion, and impact on Indian scientific capability and technology development.

A structured questionnaire was developed based on interviews. After face-validity, the instrument was e-mailed to the Fellows (national and international) of all the three academies. Usable responses were obtained from 83 members. Table 2 provides the details of the respondents. The average length of membership was 14.5 years. Most respondents were members of multiple academies.

Data Collection

The dependent variable in this study was the impact of science academies. The unit of analysis adopted was the members of the society. We attempted to capture the perceptual ratings of the internal stakeholders on the impact of the various functions of the academy. Hence, a survey method was considered appropriate. The sampling frame for data collection was Indian science academies detailed in Table 1.

Variables and Measures

Although attempts were made to use existing measures, these were not available for all the constructs, or were limited in their applicability to our research context. Thus, scales were either adopted or new ones developed for the purpose of this study. All variables were measured on a five-point Likert's scale, generally spanning between very high (scored 5) to very low (scored 1).

Resource endowment function was measured using two items measuring promotion of local scientific efforts and scientists and securing and managing funds and endowments for promotion of science. Recognition function was measured using two items capturing establishment of professorships, fellowships, scholarships, and other awards, and recognition and reward of scientists and scientific talent. Linkage functions was measuring using six-items capturing promotion and dissemination of science and science education in pure and applied form, provision of forum for publications and presentation of research, and establishment of linkages among other local scientific academies, institutes, government agencies and industry within the country and abroad. Institutionalisation function was measured on a four-item scale consisting of participation in national and international science and technology policy formulation, addressing issues of concern to the scientific community, and taking up issues related to the role of science in social responsibility. Table 3 shows the means and standard deviations for the items grouped under variables, and the reliability coefficient, Cronbach Alpha. The means for recognition and linkages functions were higher than the resource endowment and institutionalisation functions. A two way paired t-test between the above functions showed that the means were statistically significantly at $p<0.05$ level. The Cronbach alphas ranged from 0.47 to 0.80. The correlations between the variables were significant, varying from 0.324 to 0.669.

While a universal measure of impact would have been desirable, our initial interviews revealed that the impact of the three academies had been in different functions and many members were equivocal on the overall impact of the science academies. While the academies are quite democratic in their functioning, not all members get involved in the multitude of activities of the academy. Hence, many members were unable to assess the overall impact. To mitigate this, an impact index was created based on the ratings of the respondents. First, the average of the overall sample population was computed. If the individual respondent's ratings were below the average, the impact index was 0, 1 otherwise. A rating of 0 indicates low impact of the academy, while a rating of 1 indicates high impact.

Method of Analysis

To identify the factors reflecting performances of the academies from internal stakeholder perspective, a factor analysis of the items was carried out. We adopted principal-component extraction with varimax rotation. To estimate the relationship between the factors and an impact index, a binary logistic regression using step-wise was carried out. The stepwise procedure has been chosen in order to reduce multi-collinearity among variables. The initial list of regressors considered by the stepwise procedure consists of all the independent variables. Variables have been added one by one with an R^2 increment of at least one per cent.

Results

Table 4 shows the results of the factor analysis. Three factors explaining about 64% of the variance were extracted. The first factor explained about 45% of the variance. It included items related to promotion and safeguard of interests of scientists, to secure and manage funds, establish linkages within India and take up concerns of scientific community. The second factor explaining about 10% of the variance included linkages with similar bodies in India and abroad, cultivation and promotion of science, platforms for promotion such as publication, meetings and symposia. Factor three explaining about 8% of the variance included recognition and rewards of scientists and establishment of fellowship and awards. This exploratory factor analysis provides partial empirical support to our conceptual framework shown in Figure 1.

Table 5 shows the results of binary regression analysis between factor scores and the impact index. The results indicate resource endowments and promotion and linkages are the discriminating factors amongst the low and high impact groups. The results indicate that science academies need to improve promotion and safeguarding the interests of scientists, and linkages with academies in other areas and industry. Fellows also felt science academies need to make a higher impact by improving knowledge generation and presentation mechanisms and greater participation in science and technology policy-making. The model fit was high, the Cox and Snell R Square was 0.623 and Nagelkerke R Square value was 0.832. The Cox and Snell pseudo R-square measures indicate that the model performs fairly well. The Nagelkerke R^2 value will usually be the most relevant value to report. It corrects the Cox and Snell value so that it can theoretically achieve a value of 1. Note that these pseudo R^2 measures confound goodness of fit and explanatory power of the model. The likelihood ratio tests show that the null hypothesis that the effects on odds-ratios of the dependent variable are simultaneously equal to zero can be rejected for the intercept and independent variables.

Results of the binary logistic regression of items with impact index are presented in Table 6. Applying science in the cause of humanity and national welfare and participation in National Committees and other National Science and Technology policies forum, and to establish linkages and coordination among other Indian scientific academies, science institutes, government scientific departments and services (military) within the country emerge as the discriminating variables. The model fit was high, the Cox and Snell R Square was 0.683 and Nagelkerke R Square value was 0.913

To test whether length of fellowship has any impact on perceptions of the functions of the science academies, a binary logistic regression was carried out. The reasoning was long-standing fellows in communities of practice would have had opportunities to understand the functioning, establish personal networks and have greater access to resources [18]. A duration index, designed to differentiate between fellows who had been associated with academies for longer periods vs. others, was created as follows. The average of length of fellowship in number of years for each of the academy was calculated. If the respondent had been a member for less than the average they were classified as 1 and if they had been a member of the academy for greater than the average number of years he was classified as 2. Next if the respondent had been a member of any one of the three academies for a length that was less than average they were classified as 0. If the respondent had been a member of any one of the three academies for a more than the average duration (classification as 2 above) they were classified as 1.

The results of the binary logistic analysis shown in Table 7, indicates that perceptions do differ based on length of fellowship. The discriminating variables were forum for publication and establishment of linkages with similar bodies in India and abroad. Younger members felt that academies need to augment avenues for publications and improve linkages with national and international bodies. However the model fit was low, the Cox and Snell R Square was 0.136 and Nagelkerke R Square value was 0.190.

Discussion

Our objectives for this paper were to develop a conceptual framework to explain the functions of bodies like science academies and to validate this framework in the context of Indian Science Academies. Our study makes several important contributions to the literature on technology communities in general and science academies in particular. The conceptual framework proposed that Science academies pursue three major sets of functions: resource endowments, promotion and recognition and institutionalisation. Our results offer partial empirical validation for our framework.

What implications do this research study have for practice. Significant correlations amongst the variables suggests that Science academies have to pursue all the three major sets of interdependent functions, resource endowments, recognition and linkages and institutionalisation, to create a lasting impact on scientific and technological capabilities. Specifically, three areas emerge as being critical for Indian science academies. The first area relates to providing a mechanism for dissemination of knowledge though publication of research, conferences and other similar forum and via science education in pure and applied form. The second area focuses on the role of academies in forming networks of national and international linkages with other similar organizations, public and private sector laboratories, and industrial linkages. The third critical area is the participation of academies in national and international science and technology policy management and standard setting issues. Our interviews with the office bearers and senior fellows of the academies indicate that Indian government have not effectively utilized the expertise and services of the academies in policy-making and standardization. They cited several examples of how nations across the world, especially U.S, Japan and France have integrated independent inputs from academies, especially in knowledge intensive sectors such as biotech and IT [5,6].

The limitation of this study is its focus on science academies and their impact without looking at structural, organizational and process variables that impact the science and technology development. Factor (variance) research models seeking to explain the variation in outcome (impact) of science academies on the basis of antecedent variables (structure, funding, independence, participation of fellows, and role of regional chapters) could be explored. Science academies are a conglomerate consisting of a variety of science disciplines and because of 'thought' dominance [11] could focus on specific functions. Future research needs to analyse the effectiveness of science academies across countries to test whether a particular stress of functions of science academies contribute to explain the differences in national innovation systems. Studies comparing and contrasting the dynamics of functions across science and engineering academies could offer exciting contributions to communities of practice literature. Methodologically, process research models complement factor models by focusing on the dynamics of social change and providing the "story" that explains the degree of association between predictors and outcomes [24]. Process theories have not been sufficiently developed in science and technology policy studies. Process studies on selection of fellows, decision-making patterns, and agenda setting can reveal interesting insights into functioning of meso-thought communities of practice.

In summary, we have developed a framework to analyse science academies which could be extended to other similar communities. Evaluation of the functions would be of interest to policy makers and science administrators to identify mechanisms to improve the effectiveness and impact of these organizations.

References

1. Edquist, C. and Lundvall, B. A. (1993) 'Comparing the Danish and Swedish systems of innovation' In R. R. Nelson (ed.) *National Innovation Systems: A comparative analysis*, Oxford University Press: New York, pp. 265-298.

2. Edquist, C. (ed.) (1997) *Systems of Innovation: Technologies, Institutions and Organisations,* Pinter Publishers.

3. Niosi, J., Saviotti, P., Bellon, B., and Crow, M. (1993) 'National systems of innovation: In search of a workable concept', *Technology in Society*, Vol. 15, No. 2, pp. 207-227.

4. DiMaggio, P. J., and Powell, W. (1983) 'The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields', *American Sociological Review*, Vol. 48, pp. 147-161.

5. Nelson, R. R. (ed.) (1993) *National Innovation Systems: A comparative analysis*, Oxford University Press, New York.

6. Sigurdson, J. (1986, published in 1998). 'Industry and state partnership: The historical role of the engineering research association in Japan', *Industry and Innovation*, Vol. 5, No. 2, pp. 209-241.

7. Van de Ven, A. H. (1993) 'A community perspective on the emergence of innovations', *Journal of Engineering and Technology Management*, Vol. 10, pp. 23-51.

8. Knorr-Cetina, K. D., and Mulkay, M. (1983) *Science observed: Perspectives on the social study of science*, Sage, Beverly Hills, CA.

9. Zuckerman, H. (1977) *Scientific elite: Nobel laureate in the United States*, Free Press, New York.

10. Traweek, S. (1988) *Beamtimes and lifetimes: The world of high energy physicists*, Harvard, Cambridge, MA.

11. Fleck, L. (1979) *Genesis and Development of a Scientific Fact*, T. J. Trenn and R. K. Merton (trans.), The University of Chicago Press, Chicago (original work published in 1935.)

12. Anderson, B. (1983) *Imagined Community*, Verso, London.

13. Gusfield, J. (1978) *Community: A Critical Response*, Harper & Row, New York.

14. Weber, M. (1978), *Economy and Society*, University of California Press, Berkeley.

15. Douglas, M. and Isherwood, B. (1979) *The World of Goods*, Basic, New York.

16. Durkheim, E. (1965) *The Elementary Forms of the Religious Life*, Free Press, New York.

17. Niosi, J. (2002) 'National systems of innovation are "x-efficient" (and x-effective): Why some are slow learners', *Research Policy*, Vol. 31, pp. 291-302.

18. Brown, J. S., and Duguid, P. (1991) 'Organizational learning and communities of practices: Towards a unified view of working, learning and innovation', *Organization Science*, Vol. 2, No. 1, pp. 40-57.

19. UNESCO (1968), *National Science Policy of U.S.A: Origins, Developments and Present Status*, UNESCO: Paris.

20. Tushman, M. L. and Rosenkopf, L. (1990) On the organizational determinants of technological evolution: Towards a sociology of technology. Graduate School of Business, Columbia University, New York.

21. Vygotsky, L.S. (1978) *Mind in Society*, Cambridge, MA Harvard University Press.

22. Rusinko, C. A., and Mathews, J. O. (1997) 'Evolution of a technological community: A case study of financial derivatives', *Journal of Engineering and Technology Management*, Vol. 14, pp. 315-336.

23. John-Steiner, V. (1992) 'Creative lives, creative tensions', *Creativity Research Journal*, Vol. 1, pp. 99-108.

24. Mohr, L.B. (1982) *Explaining Organizational Behaviour*, Jossey-Bass, San Francisco.

Table 1: Description of Indian Science Academies Studied

Name	Indian National Science Academy, New Delhi	National Academy Of Sciences, Allahabad	Indian Academy Of Sciences, Bangalore
Year of Founding	Founded as Indian Science Congress Association (ISCA), January 15-17, 1914 in Calcutta. Renamed as National Institute of Science of India (NISI) in 1935. NISI moved to Delhi in 1945. Again renamed as Indian National Science Academy (INSA) in 1970.	1930, Registered as a Society	Registered as a Society under the Societies Registration Act, on 24 April 1934.
Present Membership	10,000 members	Founding Fellows – 19 Honorary Fellows – 39 Foreign Fellows – 55 Fellows – 1162	Fellows – 800 Honorary Fellows – 45 Associates – 30
Journals Published	Proceedings – PINSA-A and PINSA-B Indian Journal of Pure and Applied Mathematics Indian Journal of History of Science Biographical Memoirs INSA Year Book	Proceedings of the Academy (Physical Sciences and Biological Sciences) National Academy Science Letters Human Genome Research - Emerging Ethical, Legal, Social and Economic Issues	Proceedings - Chemical Sciences, Mathematical Sciences, Earth and Planetary Sciences Sadhana (Academy proceedings in engineering sciences) Pramana - Journal of Physics Journal of Biosciences Bulletin of Materials Science Journal of Astrophysics and Astronomy Journal of Genetics Resonance - Journal of Science Education Current Science

Sources: Handbook of INSA, NAS and IAS, 2002

Table 2: Details of Respondents

	INSA	IAS	NAS
Duration of membership (in years)	15	16.8	12
Membership			
INSA	17	14	11
IAS		1	3
NAS			0
All three = 35			

INSA= Indian National Science Academy
IAS = Indian Academy of Science
NAS = National Academy of Science

Table 3: Variables and measures

Resource Endowment Functions	Mean	Std. Dev.	Reliability
To promote and safeguard the interests of scientists in India.	2.81	.93	
To secure and manage funds and endowments for promotion of science.	3.06	.92	
Overall statistics	2.92	0.76	0.57
Recognition Functions			
To recognize and reward scientists and scientific talent.	3.85	.81	
To institute and establish professorships, fellowships, scholarships, and other awards.	3.31	.96	
Overall statistics	3.57	0.72	0.47
Linkages Functions			
To cultivate, promote, popularise, disseminate science and science education in pure and applied form.	3.43	.90	
To provide a forum for publications of research in the form of proceedings, journals, memoirs and other suitable publications.	3.77	.88	
To organize meetings, symposiums, conferences which provide a forum for presentation and discussion of research and science.	3.88	.91	
To establish linkages and coordination among other Indian scientific academies, science institutes, government scientific departments and services (military) within the country.	2.96	1.12	
To establish linkages and coordination among Indian Academies / Associations in other areas like technology, humanities and social sciences, management, etc.	2.66	1.10	
To establish linkages, help interact and foster collaborations with similar bodies in India and abroad.	3.79	.90	
Overall statistics	3.41	0.69	0.80
Institutionalisation Functions			
To apply science in the cause of humanity and national welfare.	2.80	1.10	
To participate in National Committees and other forum which lay down National Science and Technology policies.	3.30	1.06	
To take up issues of concern to the scientific community in India with the relevant authorities in the country.	2.52	1.03	
To take up issues related to the role of science in the areas of social responsibility, ethics, human rights, and individual freedom.	2.43	1.12	
Overall statistics	2.74	0.86	0.79

Table 4: Results of Factor Analysis

Items	Factor 1	Factor 2	Factor 3
To cultivate, promote, popularise, disseminate science and science education in pure and applied form.		.720	
To apply science in the cause of humanity and national welfare.	.618		
To establish linkages, help interact and foster collaborations with similar bodies in India and abroad.		.768	
To promote and safeguard the interests of scientists in India.	.827		
To secure and manage funds and endowments for promotion of science.	.573		
To provide a forum for publications of research in the form of proceedings, journals, memoirs and other suitable publications.		.652	
To participate in National Committees and other forum which lay down National Science and Technology policies.		.498	
To recognize and reward scientists and scientific talent.			.795
To institute and establish professorships, fellowships, scholarships, and other awards.			.736
To organize meetings, symposiums, conferences which provide a forum for presentation and discussion of research and science.		.738	
To establish linkages and coordination among other Indian scientific academies, science institutes, government scientific departments and services (military) within the country.	.714		
To establish linkages and coordination among Indian Academies / Associations in other areas like technology, humanities and social sciences, management, etc.	.735		
To take up issues of concern to the scientific community in India with the relevant authorities in the country.	.813		
To take up issues related to the role of science in the areas of social responsibility, ethics, human rights, and individual freedom.	.678		
Variance explained	45.420	10.110	8.034

Table 5: Results of Logistic Regression between Impact Index and Factors

	B	S.E.	Wald	df	Sig.	Exp(B)
Factor 1	4.847	1.397	12.032	1	.001	127.318
Factor 2	3.027	.870	12.102	1	.001	20.638
Constant	-.109	.500	.047	1	.828	.897

Table 6: Results of Logistic Regression between Impact Index and Items

	B	S.E.	Wald	df	Sig.	Exp(B)
To apply science in the cause of humanity and national welfare.	6.826	2.467	7.656	1	.006	921.920
To participate in National Committees and other forum which lay down National Science and Technology policies.	3.305	1.261	6.866	1	.009	27.247
To establish linkages and coordination among other Indian scientific academies, science institutes, government scientific departments and services (military) within the country.	3.835	1.550	6.118	1	.013	46.287
Constant	-40.514	14.012	8.361	1	.004	.000

Table 7: Regression of Logistic Regression between Duration Index and Items

	B	S.E.	Wald	df	Sig.	Exp(B)
To establish linkages, help interact and foster collaborations with similar bodies in India and abroad.	.806	.382	4.466	1	.035	2.240
To provide a forum for publications of research in the form of proceedings, journals, memoirs and other suitable publications.	-1.214	.459	7.011	1	.008	.297
Constant	2.412	1.553	2.412	1	.120	11.160

Figure 1: A community framework of Scientific Academies