Chapter 6

Conclusions and Recommendations

6.1. Introduction

In this chapter, a summary of the key findings from the current study is presented along with conclusions and implications, limitations of the study, recommendations for professional and academic advancement of the field of science communication in India, and further research on expanding our understanding of scientists' perspectives about science communication with the general public and the media.

As evident from the extant literature review, there are no scientific and systematic studies exploring and describing Indian scientists' perceptions, attitudes, and behaviours toward science communication with the general public and the media. To address this critical gap in literature, this thesis provides first-ever empirical evidence from India on scientists' views and behaviours toward science communication; objectives of science communication; media coverage of science; science-society interactions; their duty, role and responsibility; willingness to engage; factors preventing their active engagement; their personal attributes for successful science communication performance, and what they think about how their public engagement can be enhanced. The purpose of this thesis was to provide exploratory and descriptive answers to the aim and objectives on how senior Indian scientists perceived science communication in general and how they viewed their own engagement behaviours.

The current study sample consisting of very senior and experienced scientists, who are scientifically very productive and more than half of them occupied top scientific/administrative positions in their institutions, even makes the current findings more

significant. Views, attitudes, and behaviours of these top Indian scientists are expected to set examples for junior and mid-career scientists to think about their own public engagement views and behaviours. A summary of the main findings of this study is presented under each objective's heading. The results for these objectives are presented and analysed in Chapter 4 and are discussed in Chapter 5.

6.2. Objective 1 – Science communication, its importance and roles and responsibilities of scientists

Science communication is intended toward betterment, welfare and advancement of society, and media play an important role as a link between science and society. So the importance of one is linked to that of the other two as well. The senior Indian scientists expressed a high level of importance for communicating science to the public, its objectives, and different public communication methods. They showed a high level of agreement for the given statements about science-society interactions and expressed displeasure about the low level of science coverage in the Indian news media. While advocating for enhancing the science-society linkages through more dialogue between science and society, most respondents believed that they have a moral duty, role, and responsibility for science communication with the general public. Interestingly, the respondents' perceptions and attitudes did not show any meaningful differences across the independent variables. The key findings of this empirical study of senior Indian scientists addressing the first objective are summarised as bellow:

- Communicating science to the general public was given high importance by almost all the respondents (97%).
- Most Indian scientists believed that all the given objectives of science communication – Informing and educating the public, Simplifying science, Inculcating scientific

temper, Creating excitement about science, Building public trust in science, and Contributing to policy making – were important.

- It is suggested that science communication efforts in India should be a perfect mix of both the deficit and engagement models while also ensuring to build public trust in science and contribute to policies.
- All the different ways of communication (face-to-face interactions, TV/video, radio, print and online) were recognised by Indian scientists as important for ensuring enhanced engagement between science and society.
- The highest importance was given to 'face-to-face interactions,' suggesting a need to establish a direct link with the public through two-way dialogue and communication.
- In terms of mediated communication, visual media got relatively more importance than radio.
- Most scientists believed that the current level of science coverage in Indian news media was below average.
- Scientific ignorance is a hurdle in the advancement of science.
- Scientifically ignorant public can oppose science projects.
- Public awareness of scientific issues should be increased.
- Better linkages between science and society are needed.
- Communicating science to society/taxpayers is part of a scientist's job's role and responsibilities.
- Scientists have a moral duty to inform society about what research they are doing with taxpayers' money.
- Scientists are responsible for communicating their research to the public (69.11%).
- Science communication should be an essential part of a scientist's duty/job (69.50%).
- Scientists should play an active role in science communication (84.17%).

- Science communication specialists are projected to lead public engagement efforts in sharing the main responsibility with scientists for public communication.

6.3. Objective 2 – Science communication by scientists and its impact on their career advancement

Much of the literature shows that scientists are not very active in science communication activities, and they are discouraged from engaging with the general public because of being called a publicist if they do so (what is popularly known as the Sagan Effect) and their engagement not having any value for their career advancement. However, it is found that Indian scientists have positive perceptions and attitudes toward their involvement in science communication activities, their experience, performance, and capabilities to do such activities, and are largely aware of the possible impacts of their science communication engagements. Further, it is found that scientists' perceptions and attitudes about their engagement behaviours in science communication and their institutions' public engagement were largely independent of the demographic variables. The important findings under this objective are summarised below:

- Almost all the respondents have participated in some science communication activity during their careers. However, most of them (60%) participated occasionally or rarely, with less than 40% doing it often.
- Similarly, most institutions (61%) organised public engagement events occasionally or rarely, with 36% doing it often.
- Individual scientists were relatively more frequent in their engagement with the public than their institutions organising such events.

- During the last one year, the majority of the respondents had face-to-face interactions with the public (79%), talked at schools and colleges (88%), gave interviews to journalists (63%), and wrote popular science (64%) at least once. However, most of them never wrote about popular science online (65%) or shared videos online about their research (72%) during the last year.
- More than one-third of the respondents never gave interviews to journalists (37%) or wrote popular science (36%) during the previous year.
- Senior scientists appeared to be more comfortable communicating science with the general public through traditional and direct communications than online modes of public engagement.
- More than three-quarters of the respondents (77%) expressed willingness to engage in science communication activities in the future if opportunities were provided.
- The overall experience in communicating science with the general public has been either 'good' or 'very good' for about three-quarters of the respondents (74%).
- Public engagement was neither 'very difficult' nor 'very easy' for about 88% of the respondents, but it was either easy or very easy for 46% of respondents.
- About 53% of respondents rated their overall public engagement as 'good' or 'very good.'
- More than three-quarters of the respondents believed that they enjoyed public engagement and were confident and well-equipped to communicate their research.
- Indian scientists have encouraging attitudes toward the possible impacts of their engagement in science communication activities.
- The majority of scientists believed that their engagement in science communication activities would increase scientific knowledge of the public, scientists' own scientific knowledge, and scientists' confidence in public communication, provide scientific

information for wider public use, and popularise their research. However, the majority did not believe that it would increase public support for their research.

- Most of the Indian scientists were not sure if their participation in science communication activities played an important role in advancing their scientific career, but a large majority was certain that it did not impact their career negatively.
- Most of them also believed that it does not help them get more research funding or recognition from their employers.
- The majority of scientists (67%) did not believe that scientists engaging in science communication were labelled as 'publicists' by their peers, which was bad for a scientist's career.
- Participating in science communication activities, getting research findings covered by the news media, and promoting research findings on social media were only moderately crucial for a scientist' career advancement.

6.4. Objective 3 – Factors affecting scientists' active engagement in science communication with the general public and media

Much of the literature on science communication shows that scientists face several impediments and barriers in their active participation in science communication activities. Their active engagement is impacted by personal, professional, institutional, and social challenges. The main findings of this study addressing the objective on factors affecting scientists' active engagement are summarised here:

- Less than half of the respondents (47.49%) viewed their employers or institutions as supportive of their science communication activities.

- Just like the respondents, their close academic colleagues were also occasionally active in science communication.
- Respondents were not sure whether many of their colleagues at their institutions or departments were active public communicators of science.
- Family and close friends were relatively more supportive than academic colleagues to a scientist's participation in public engagement activities.
- There was a general disagreement among the respondents that their research was too complex for the general public to understand.
- The majority of senior Indian scientists did not believe that their active involvement in science communication was affected by the given 11 factors (Lack of time, No interest in such activities, Lack of communication skills, No incentives/rewards and recognition, Deviation from research, Difficulty in constructing messages relevant for the public, No personal benefits, Lack of institutional support/encouragement, Lack of funding, Lack of comfort in such activities, and Science communication is not part of my duty).
- However, consideration number of scientists believed that lack of time, lack of funding, difficulty in constructing public messages, and deviation from research were potential factors affecting their active engagement.
- Most Indian scientists believed that they were quite skilled in using the given media formats to communicate science with the public but relatively more skilled in face-to-face interactions, print and online media than electronic media (TV/videos and radio).
- A large majority of the respondents (85.33%) have learned skills in communicating science to the public/media on their own through experience, without any formal training.
- More than 50% of the respondents did not believe that they have enough training in science communication.

- About 68% were hopeful that attending science communication training or workshops would help improve scientists' public engagement.
- Most of them were neither willing nor unwilling to attend science communication/media training.
- A vast majority of Indian scientists (72.98%) were willing to participate in science communication activities in the next 12 months.
- Regression models with the different factors covered under this objective revealed that these potential factors explained about 34% variation in the respondents' willingness to engage. If these factors are addressed, then the respondents are more likely to engage in science communication activities.

6.5. Objective 4 – Needed interventions for enhancing science communication by Indian scientists

When scientists are asked to contribute more to communicating science with the general public and be more active in such activities, they are faced with barriers limiting their active engagement. Therefore, it is pertinent to understand what scientists themselves think about enhancing scientists' involvement in science communication activities. The respondents were asked to give recommendations for enhancing science communication by scientists in the future. The respondents recommended eight out of the given ten interventions for enhancing science communication by scientists in India. They recommended:

- Ensuring institutional support/encouragement for such activities (90.74%).
- Every S&T institution should appoint science communication specialists who are experts in engaging with the public and the media (79.15%).
- Providing financial support for such activities (76.06%).

- Training scientists in communication and media skills (72.97%).
- Guidelines for scientists on how to communicate with the public (65.64%).
- Appropriate policy for science communication by scientists (64.87%).
- Integrating science communication training as a mandatory part of science education at college and university level (62.55%).
- Offering rewards/incentives to scientists (50.58%).
- Only a minority but still a significant proportion of the respondents recommended: Making it mandatory for scientists to communicate with the public (31.66%) and Considering science communication activities in the annual assessment and promotions of scientists (37.84%).
- All the interventions were positively and statistically significantly correlated with the respondents' likelihood of engaging in science communication activities in the future.
- Results from regression models indicated that scientists were more likely to engage in public communication of science activities in the future if these interventions were made available.

Based on open-ended comments, the following recommendations emerged:

- Need for communicating science in Indian (and local) languages and enhancing scientists' ability to communicate science in simple language and in their mother tongue.
- Need for local examples to establish a better connection with the target population.
- Retired scientists should be pulled in to increase science communication efforts by encouraging them financially.
- Improving the quality of science education at school and college levels.

- Funding agencies should include science communication with the public as a component of all the funded projects.
- Institutions should allow scientists to directly talk to the media without prior permission for sharing their published work or basic science.
- Need to increase public trust in science and scientists.

6.6. Implications

This thesis provides the first-ever empirical evidence about Indian scientists' views, perceptions, attitudes, and behaviours toward different aspects of science communication. Surveys assessing scientists' perceptions have been conducted in several countries over the last decade, but there was no initiative in India, creating a significant gap in the field. The current study's findings are comparable with the results of several studies on science communication views of scientists conducted in different parts of the world. Filling the vital knowledge gap, it provides baseline data for further international comparisons and further research.

This quantitative baseline study of science communication views, attitudes, and activities of top scientists would be helpful to the larger Indian scientific community to help them assess and develop their own beliefs, attitudes, and behaviours toward the public communication of science. The findings would act as a reference point for junior and mid-career scientists to compare their own science communication perceptions and activities.

The institutions appeared to be not very active in organising science communication activities from scientists' own experiences and perceptions. Also, many scientists suggested that their institutions were not very supportive of science communication by scientists, while a vast

majority recommended institutional support for enhancing public engagement by scientists. This situation provides an opportunity for institutions to introspect and do the needful to prioritise science communication and outreach activities and devise appropriate mechanisms for encouraging and incentivising science communication by scientists.

The study's results suggest that most scientists did not have any formal training in science communication, but they believed that science communication training/workshops would help improve scientists' public engagement efforts. They highlighted that appropriate training and capacity-building interventions for scientists to help them enhance their communication and media skills to finally become better equipped and more effective public communicators of science.

The current findings indicate that if the potential factors preventing science communication by scientists are addressed and the necessary interventions recommended by scientists to enhance science communication by scientists are implemented, the chances of Indian scientists engaging with the public in the future would increase. This is a potential area where the government and institutional agencies need to work to identify and devise appropriate mechanisms for eliminating the potential preventative factors and implementing the recommended interventions to create a conducive and encouraging ecosystem/culture in Indian R&D institutions where science communication is a priority and active participation by scientists is valued.

Also, several of the current findings can inform the future policies for enhancing science communication by scientists in India. The empirical evidence presented in this thesis would guide science communication policies at the government or institutional levels to further

improve the active involvement of scientists. The institutions must make appropriate policy changes to establish science communication departments or recruit science communication specialists, as recommended by top Indian scientists in this study. Another policy implication is to revolutionise the science education system at school/college levels to move away from rote-learning to activity-based learning, where communication skills are also imparted. Policy interventions are needed to introduce science communication training and skill enhancement at undergraduate, postgraduate, and doctoral levels to create future generations of scientists ready for public engagement. Government and institutional agencies should also identify ways where scientists with science communication experiences are made available to mentor young researchers.

6.7. Limitations of the study

This empirical study explores and describes scientists' views, attitudes, and behaviours using only individual scientists' responses to the survey questionnaire. The assessment of some aspects covered in this thesis – for example, frequency of institutions organising science communication events, institutional support for active involvement, colleagues' participation in public engagement activities, science communication being part of the job, etc. – are mainly based on individual scientists' perceptions and opinions.

As scientists' involvement in science communication activities and their frequency of participation is assessed by using self-reporting based on their own perceptions in a survey questionnaire, the actual engagement and the quality of communications cannot be ascertained. However, that was not the purpose of this thesis. The intended aim was to provide a snapshot of the current state of affairs about senior Indian scientists' science communication perceptions, attitudes and behaviours, for which survey methodology was

best suited. Also, instead of in-depth analysis, the study provides a larger picture of the science communication landscape in India from the scientists' point of view. It serves the study's intended purpose to provide baseline data of top Indian scientists' views, attitudes, and behaviours in science communication, which can guide young researchers and further research on this crucial topic.

As the study intended to provide baseline data on the Indian science communication scenario from senior Indian scientists' perspective, the target population was selected as the elected fellows of three Indian national science academies who are generally senior, experienced and top scientists of their respective fields. So, the resulting sample of the current study consisted of senior and experienced scientists only. A limitation of the study is that the younger scientists were deliberately not included. Also, even senior scientists who were not elected fellows were excluded to keep the study manageable. Also, participation in the study being voluntary, there are chances that more scientists holding positive attitudes about or having favourable experience in science communication took part in the study. These limitations might restrict the generalisability of the findings to the entire scientific community in India. However, this does not appear to be the case as not all scientists expressed positive attitudes or experiences in the survey.

A larger proportion of the respondents expressing positive attitudes toward several constructs and concepts measured reflects the respondents being aged more than 55 years, having more than 30 years experience and more than 50% of them being at top positions, rather showing a positive bias.

The limitations of the current study offer opportunities for future research with larger sample size, including young researchers, to advance our understanding of how Indian scientists engage in science communication activities.

6.8. Recommendations

6.8.1. For individual scientists

Most of the respondents of this study believed that science communication is part of their job and they have moral duty to communicate. Whether it is prescribed as a job role of a scientist or not, individual scientists should be more open to public engagement activities, at least for a personal sense of responsibility in pursuance of the constitutional and science policy provisions. When scientists are increasingly required to participate in public debates on science, especially in democracies, to gain public support, it is advisable to acquire requisite media skills and communication proficiency to engage with different publics and stakeholders effectively. An understanding of how different media formats work is desirable. Therefore, attending appropriate training or workshops on science communication, media skills, science-society interactions, etc. as part of individual scientists' personal initiative is recommended. When individual scientists are not able to communicate their research themselves, they should coordinate and cooperate with science communication specialists or their outreach personnel to take the message of the research to the larger society. Around the globe, scientists and other stakeholders are increasingly recognising the need for scientists to share responsibility for giving back to society when taxpayers fund their research and salary, at least at publicly-funded R&D institutions.

6.8.2. For R&D institutions

From the findings of the current study and the literature review, it is observed that institutional support and encouragement are considered potential enablers for scientists' active participation in science communication activities. If institutions give due priority to science communication with the general public and recognise and incentivise such efforts, more individual scientists would come forward to contribute.

As many scientists in the current study and several other studies elsewhere believed that their institutions are not supportive of scientists' public engagement, R&D institutions should reconsider their position on public engagement with science and scientists' role in it. Institutions should encourage science communication by scientists, at least those who are willing to contribute. Such scientists should be helped by institutions in terms of their skill enhancement and training, opportunities for public communication, personal benefits, and consideration in career advancement.

When publishing in high impact journals is the main parameter for assessing individual scientists' progress and academic contributions, then obviously junior and mid-career scientists would like to focus on increasing their tally of such publications instead of talking to the public or media. They would be less likely to engage with the general public or media if such activities do not add to their career progression. Scientific institutions should look into it and devise appropriate policies and guidelines for science communication by scientists and how such efforts would be evaluated and valued for scientists' performance appraisals and promotions.

Some mechanism should be established at the institutional level where excellent contributions by scientists in public engagement and outreach are recognised and rewarded through awards, citations, cash rewards, and other forms of appreciation and recognition. This is important because behaviours that are valued, recognised and rewarded only attract more people doing it.

A considerable number of scientists noted that lack of time, lack of funding and deviation from research are potential factors preventing their active involvement. Institutions should provide an environment where such issues are appropriately addressed to ease the barriers to scientists' public communication. Appropriate funding provisions should be there for science communication in the annual institutional budgets.

Scientific and academic institutions should ensure proper training and capacity building of young and mid-career scientists in communication and media skills through courses and workshops. As part of science education, at least at master and doctoral levels, there should be a paper on science communication – both theory and practice. The pre-PhD coursework should have a mandatory paper on science communication. Institutions should regularly arrange short-term workshops and refresher courses for mid-career and senior scientists to help hone their communication and media skills. Even efforts can be made to identify scientists' specific limitations and challenges in public communication which can be addressed through special training modules.

The R&D institutions should consider addressing the potential factors and barriers identified by scientists and the possible interventions recommended for further improving public engagement by scientists in this study.

6.8.3. For government and funding agencies

There is a need for common policies and guidelines from the central government and funding agencies. To make it easy and a general convention across institutions, areas of research and other categorisations, a set of standard guidelines for public communication of science by individual scientists and scientific institutions would guide institutional policies as per their own institutional requirements and mandates.

To encourage science communication by scientists, governments and funding agencies should establish a mechanism for including science communication with the general public as a part of grant/funding proposals. Such proposals should have a section on science communication where it is required to explain how the outputs of the proposed research would be communicating to the general public directly and through the media. Under a science communication heading, a certain percentage of the research budget should be earmarked for science communication activities. That is, every funded project should have a component on science communication with specific funding provisions for the same. As part of the project completion requirements, researchers should be asked to submit documentary evidence of having done science communication and outreach activities as stated in the proposal with the earmarked funds.

Just like the scientific output is measured in terms of peer-reviewed publications/reports or patents, specific rubrics should be identified for measuring and evaluating the quality and impact of science communication and outreach. Such metrics should be considered for researchers' or scientists' performance evaluation as well.

Also, in addition to including science communication as a part of every research project, governments and funding agencies should encourage standalone science communication and public engagement projects by interested scientists or science communication professionals.

The various initiatives in the country through the National Council for S&T Communication (NCSTC) under the Union Department of Science and Technology need to be further strengthened and amplified.

Under such science communication initiatives, more focus should be on communicating science in the Indian or local languages. There is a dearth of communication material on science in Indian languages in any form – print, electronic or digital. There should be more science communication institutions such as Vigyan Prasar to further expand science communication efforts at state/regional levels through Indian languages. Also, efforts should be made to encourage scientists to talk and write about their research or science in general in their mother tongue to address the shortage of material on science in Indian languages.

Scientists should not be demeaned for their public engagement but encouraged, recognised, and incentivised. There is a perception among certain sections that scientists who are more active in public engagement and science outreach do not perform much research or are less interested in research; this perception should be changed.

The national science academies are also required to play an active and proactive role in promoting science communication and public engagement by scientists or their fellows/members. The Royal Society in the UK and the American Association for the Advancement of Science (AAAS) in the USA appear to be conscious of the importance of

science communication. They are active in supporting different initiatives, including training for scientists and media persons to communicate science better. Indian science academies should prioritise debate on the importance of science communication and scientists' role and responsibilities and identify critical areas for further improvement, especially for training and capacity-building of scientists. As the current findings suggest scientists to meet up with science communicators to share the main responsibility for communicating science with the general public, an initiative for strengthening and facilitating scientist-journalist/communicator linkages or collaborations is desirable. Short-term exchange programmes for scientists at media outlets or communicators/journalists at scientific institutions would act as icebreakers for further fostering scientist-communicator collaborations.

The government should create appropriate and ample avenues for building and ensuring public trust in science and scientists through public debates on scientific topics where scientists also participate and not only express their views freely but also listen to the public's views.

6.8.4. For academic institutions

There are few initiatives in the country to promote research on science communication. Globally, science communication is being recognised as a specialised field of expertise – both academically and professionally. Different universities and other academic institutions are offering masters and doctoral programmes in science communication. Efforts are being made to create a strong pool of skilled and trained science communicators through formal training in the form of degree/diploma courses. Different aspects of science communication, including public attitudes toward science, scientists' perceptions and behaviours toward the public and

science communication, science-society interactions, science policy, science governance, etc. are addressed through advanced research at academic institutions. However, the Indian academia appears to have ignored this vital area.

To promote formal training and organised research in science communication, universities and other academic institutions such as IISERs, IISc, AScIR, IITs, and professional/academic scientific societies/academies should establish departments for science communication. Many universities and colleges with journalism and mass communication departments should have professors with specialisation in science communication or public engagement and at least include a mandatory or elective paper on science communication as part of their degree, diploma or certificate programmes. Media and communication students should get opportunities for doing their internship or summer projects on science communication with scientists at R&D institutions, in addition to doing their projects at media outlets.

Institutions imparting training and degrees in science, technology, engineering, agriculture, and medicine (STEAM) should include science communication as a mandatory subject and treat a candidate's ability to communicate science to different audiences directly or through the media as a core skill. Science communication training at undergraduate, postgraduate and doctoral programmes should include both theory and practical aspects. They should be provided with opportunities to learn communication and media skills through practice and project work.

Further, it would be a good idea to institute national chairs for science communication at advanced academic and research institutions to promote this area of expertise in the country.

6.8.5. For the media and press

As it is evident through several studies as well as anecdotally that science coverage in the popular news media in India remains to be low, media outlets should give a thought on how to increase science coverage. Much research is happening in the thousands of research labs and centres in the country, which the taxpayers have a right to know. Popular newspapers, TV news channels, and radio channels are the primary sources for the general public to learn anything new about science and technology. The general perception that scientists do not engage is proven otherwise, at least from the current study's findings. Therefore, there is a need for having science beat reporters and writers who have some science background or passion for covering and reporting on scientific topics.

6.8.6. For science communicators

A high proportion of the top scientists in this study believed that science communication specialists should have the main responsibility for communicating science to the general public, with the active involvement of scientists and the support of media, government and funding agencies. Science communicators should take the lead in talking to scientists and preparing public communication materials based on scientists' papers in consultation with scientists while also coordinating with the media, institutional authorities, etc. However, science communicators' efforts would not succeed without the active involvement and cooperation of scientists. Science communicators at R&D institutions should prepare articles, news stories, video bytes, audio bytes suitable for use by the popular news media. Such efforts would potentially increase the coverage of science content in the media. Science communicators should also facilitate journalists' queries and interactions with scientists through the necessary administrative processes and help in getting requisite permissions.

They should maintain a strong liaison with media persons/journalists and act as mediators between scientists and journalists in pitching science stories for public consumption. Science communicators can also be a bridge for scientist-journalist collaborations and facilitators for training and capacity building initiatives.

6.9. Future research

The current research provided a baseline of senior Indian scientists' views, attitudes, and behaviours. Several hypotheses can be drawn from the current findings providing potential ideas for further research on science communication by scientists. As this thesis is limited to the elected fellows of three Indian national science academies who are relatively very senior and experienced top scientists in the country, further studies including younger researchers/scientists would add to our understanding of Indian scientists' perspectives.

Some may also see the findings of the current study of elected fellows of three academies as views and behaviours of the elite scientific community in India. Further research should include views of scientists who are not elected fellows of these elite academies.

As the current study provides a general understanding of what scientists think about different aspects of science communication, several of the topics touched here should be investigated further. For example, this study provides an understanding of how frequently Indian scientists use different media formats. Still, the exact quantification of their public communication activities and the quality of such activities is a potential topic for further research.

As the current study sample consisted of highly senior and experienced scientists, no statistically significant differences in the findings were observed based on the demographic

variables. Further studies should include a larger diversity in age and experience to get a more representative view of the larger Indian scientific community. More focused studies may even investigate scientists' public engagement in specific science disciplines or at specific institutions. Much is yet to be understood about science-society interactions, scientist-journalist/communicator collaborations, evaluation of public engagement by scientists and their communication skills, institutional dynamics related to science communication, state of science communication from journalists' point of view, scientists' ability to communicate in local languages, in-depth analysis of communication barriers to scientists' active engagement, media coverage of science, etc. These are potential topics for further research.

Another topic can be measuring the impact on a scientist's communication views and behaviours before and after addressing the potential factors and interventions identified in this study. Views and behaviours of scientists before- and after- training in science communication is another potential topic of further research. It would be a fit topic for further in-depth research to understand why the overall frequency of most scientists remains low despite their positive views, attitudes and experiences in science communication.

6.10. Concluding remarks

This exploratory and descriptive study provides a snapshot of what Indian scientists think about their involvement, performance, experience, and willingness to engage in public engagement activities and the perceived impact of their engagement on scientists, their research and society. It provides strong evidence that almost all the respondents have participated in some science communication activity during their careers and have a strong sense of moral duty and responsibility for public engagement. However, despite positive

attitudes and willingness to engage, the frequency of individual scientists and their institutions remains low. Scientists identify potential factors affecting their public engagement and recommend appropriate interventions for enhancing science communication by scientists in India. Institutional and governmental agencies in India should consider the insights provided by top Indian scientists to devise appropriate interventions to create an encouraging ecosystem where scientists can actively and proactively contribute to communicating science with the public while ensuring the availability of science communication specialists at R&D institutions lead public engagement efforts. Training and capacity building in science communication for scientists appears pertinent as the new Indian science policies are drifting toward mandating scientists' participation in public engagement.