Chapter 3

Research Methodology

3.1. Introduction

This chapter describes the research methodology used for collecting and analysing data for the current study. The area of science communication is expanding both academically and professionally across the globe since the movement for public understanding of science started in the early 1990s in the West. Many aspects of science communication, including ways and channels of public communication, public perceptions, and scientists' attitudes and practices, are being investigated from both professional and academic perspectives. With the changing times and technological advances, the ways of exchanging ideas and communication behaviours have changed a lot from traditional popular talks/articles to new media engagements. Science communication has walked from the one-way deficit model to the two-way dialogue and engagement models. As evident from the extant literature (as discussed in the chapter on Literature Review), much work is being done in this field in western and European countries. However, science communication is yet to pick up as a potential area of academic research in India. Especially, there is a lack of literature investigating different aspects of science communication from the Indian scientists' point of view. The present study, "Science communication by scientists: A study in the Indian context," tries to fill this critical gap in the literature.

3.2. Research strategy, design and method

As research on science communication in India is at its infancy stage, so much is unknown about its various aspects, especially from the scientists' point of view. Studies in this regard are rare in the Indian context. In the absence of a clear understanding of Indian scientists' perspective about science communication, some baseline data in this regard would be instrumental to guide and prioritise further research and devise appropriate interventions for enhancing science communication by scientists and their capacity building. This empirical research tries to build some baseline data on this topic by exploring and describing Indian scientists' views, opinions, attitudes, engagement behaviour (practices), training needs, and recommendations for enhancing science communication by scientists. When little empirical evidence is available, exploratory research is most suitable to gain new insights and explanations about problems that are not clearly understood (Kothari & Garg, 2014; Dillman, Smyth & Christian, 2014; Stockemer, 2019). While helping to detect possible patterns and relationships in the collected data, exploratory research provides new evidence that lays the foundation for further research. As the study also aims to understand the current state of affairs about how senior Indian scientists engage in science communication, so there is a descriptive element as well to this study. Descriptive research provides a 'snapshot' of thoughts, feelings, or behaviours at a given place and a given time (Stangor, 2011). Therefore, to address the aim and objectives of the current study, exploratory and descriptive research design is used. As this empirical study does not aim to collect in-depth information but to capture a larger picture of the perspectives of Indian scientists in science communication, so a quantitative research strategy, instead of the qualitative one, is used. This research uses a quantitative method of data collection and analysis where the concepts studied are treated and measured as quantities (Bryman, 2012:35). Quantitative methods are used to provide numerical descriptions of variables or phenomena and establish or assess empirical relationships (Stockemer, 2019) and create a database of a sample's characteristics, and infer the same to the population (Kothari & Garg, 2014).

As the study mainly focuses on investigating the current picture of scientists' wide range of perspectives in science communication without manipulating any of the variables, so the study uses an *ex post facto* research design. Also, the study is not intended to observe trends over a period but to capture a snapshot at one point in time; therefore, the research uses a cross-sectional design approach. Also, the study can be categorised as field research as the data is collected under the actual environmental conditions.

Self-administered and self-reported interview through an online survey questionnaire was used as a method of data collection. Over the past 20 years, online surveys, compared to other forms (face-to-face, mail-in or telephonic), have increasingly become more prevalent in research (Stockemer, 2019, p.66). In self-administered questionnaires, the respondents read all the questions and the related instructions themselves and answer the questions themselves (Bryman, 2012, p.233).

Here, it is crucial to understand what a survey is. Groves et al. (2009), in their book *Survey Methodology,* define a survey as "a systematic method for gathering information from (a sample of) entities for the purposes of constructing quantitative descriptors of the attributes of the larger population of which the entities are members" (p.2). Here, the quantitative descriptors are statistics that are very useful in numerically describing phenomena and in determining relationships among variables (Groves et al., 2009; Stockemer, 2019). In simpler terms, Stockemer (2019) defines survey research as the systematic collection of information from individuals using standardized procedures, normally by asking questions to a sample of the population about their perceptions, attitudes, or behaviours. Survey methods are used globally as one of the best ways for collecting empirical data for research addressing people's perceptions, attitudes, beliefs, experiences, etc. (Groves et al., 2009; Dillman, Smyth &

Christian, 2014; Stockemer, 2019). Among the different forms of surveys, online surveys using emails contacts is the fastest growing form of survey across the world (Dillman, Smyth & Christian, 2014).

Much of the research focusing on scientists' perceptions, attitudes, and behaviours toward science communication, as evident from the literature review, has also used survey methods implemented through different techniques, including face-to-face interviews, telephonic interviews, focus-group interviews, offline and online questionnaires. Survey method with the use of questionnaire appears to be the most commonly used method and technique by science communication researchers for collecting quantitative data on views, opinions, experiences, perceptions, etc. of scientists (*e.g.*, Gellert, Higgins, Lowery, & Maxwell, 1994; Wellcome Trust, 2001; Conradie, 2004; Royal Society, 2006; Nielsen, Kjaer & Dahlgaard, 2007; Poliakoff & Webb, 2007; Martin-Sempere, Garzon-Garcia, & Rey-Rocha, 2008; Davies, 2008; Petersen, Anderson, Allan, & Wilkinson, 2009; Ecklund, Neresini & Bucchi, 2011; Kreimer, Levin & Jensen, 2011; Roten, 2011; Searle, 2011; James & Lincoln, 2012; Escutia, 2012; Besley & Nisbet, 2013; Peters, 2013; Dudo et al., 2014; Jia & Liu, 2014; AAAS, 2015; Boëte et al., 2015; Pew Research Center, 2015; Dudo & Besley, 2016; Dudo et al., 2018; Llorente, Revuelta, Carrio & Porta, 2019; Farahi, Gupta, Kraweic, Plazas & Wolf, 2019; Merino & Navarro, 2019; Rose, Markowitz & Brossard, 2020; Valinciute, 2020).

A questionnaire is a convenient and reliable tool for collecting data from a large population of potential respondents, especially if they are distributed at different locations across a large geographical area. As the current study intends to collect data from as many senior Indian scientists as possible, a survey method (questionnaire) was considered the most appropriate way to address the research aim and objectives. Further, when the respondents are busy scientists located at different R&D institutions across India, an online questionnaire survey was considered the best possible data collection technique. Using online questionnaires is desirable as most communications among the scientific community nowadays are happening through the internet and emails. Also, survey questionnaires are very useful in collecting numerical data for quantitative research. Therefore, to address the research objectives, a nationwide cross-sectional online survey (questionnaire) was used as a quantitative method for collecting empirical data from scientists who are the elected Fellows of three national science academies in India (IASc, INSA, and NASI). A cross-sectional survey design was selected because it involves collecting quantitative or quantifiable data on several variables from many cases or entities at a single point in time that can be used for detecting patterns of association or relationship (Bryman, 2012, p.60; Stockemer, 2019, p.31). A cross-sectional survey is conducted only once without being repeated (Stockemer, 2019, p.31).

3.3. Population

Through this exploratory and descriptive study, an effort is made to understand what Indian scientists think about the various aspects of science communication. All the scientists working in various research areas at different academic and R&D institutions (government, private, commercial, and NGOs) across India constituted the universe for this study. With the intention to study senior and experienced scientists from the Indian scientific community, efforts were made to identify a manageable sample for the target population that draws its members from all the different academic fields, different academic/R&D institutions, and different linguistic, regional, and cultural backgrounds.

India has three prestigious, respected, and esteemed national science academies – Indian Academy of Sciences (IASc), Bengaluru; Indian National Science Academy (INSA), New

Delhi, and National Academy of Sciences, India (NASI), Prayagraj (erstwhile Allahabad). It is a great honour and recognition to get elected as a Fellow of any of these three academies. It is worth mentioning here that these academies elect academicians/scientists/researchers as their Fellows only after they have achieved a certain high level of experience and expertise in their respective research areas and have contributed significantly to the advancement of research in their area. Many scientists with significant research contributions get elected as a Fellow of one or more of these academies. IASc normally elects not more than 35 Fellows each year. INSA elects Fellows up to a maximum of 40 annually till the total number of living Fellows reaches 1000. NASI elects a varying number of Fellows every year, with the maximum number of Fellows not exceeding 2000.

The elected Fellows of these academies are generally top-rated, experienced, and celebrated experts and senior members of their respective fields of expertise. Also, these academies have their fellows who come from different scientific disciplines, hail from different parts of the country, and serve at different academic or research institutions under different work environments (governments – central/state, private, and NGOs) across the country. This population of elected fellows makes a representative sample of the Indian national scientific community. Therefore, the Fellows of IASc, INSA, and NASI constituted an ideal target population for the current research to draw a sample of scientists who are relatively senior and experienced in their respective fields.

3.4. Sampling

The Fellows of these three national science academies (IASc, INSA, and NASI) were considered as the potential population of scientists (as a representative voice of the Indian scientific community) for this study. With the intention to collect as many responses as possible, so instead of selecting a sample design, all the Fellows of the three academies with valid and available email IDs were included in the study. It allowed all the members of the population an equal chance of participation in the study (Stockemer, 2019) while building a completely random (with the highest probability) sample of respondents on the go and maximising the number of responses.

3.5. Email databases

Three academies (IASc, INSA, and NASI) publish their annual yearbooks containing information about all their Fellows and Members, including their contact details. Therefore, the latest yearbooks (2018) of these academies (at the time of the study) were collected, and emails were extracted to prepare academy-wise email databases of elected Fellows. While preparing the email databases, only elected Fellows were considered for the sake of uniformity across the three academies. Other fellowship categories such as Foreign Fellows, Honorary Fellows, and *Pravasi* Fellows; and membership categories such as Members, Associate Members, and Life Members were excluded from the email databases. IASc, INSA and NASI had 1077, 931 and 1664 elected fellows respectively as per their respective 2018 yearbooks. Finally, three academy-wise email databases of elected fellows [1) Fellows of IASc, 2) Fellows of INSA, and 3) Fellows of NASI] were prepared.

3.6. Questionnaire instrument: Development and testing

After a thorough literature review, a survey questionnaire was selected as the method for collecting empirical data for the current study. The questionnaire prepared for this study was inspired by the researcher's own experience in science communication and several survey-based studies exploring scientists' perceptions, attitudes, and behaviours (*e.g.*, Wellcome Trust, 2001; Royal Society, 2006; Nielsen, Kjaer & Dahlgaard, 2007; Poliakoff & Webb, 2007; Martin-Sempere, Garzon-Garcia, & Rey-Rocha, 2008; Davies, 2008; Kreimer, Levin & Jensen, 2011; Roten, 2011; Searle, 2011; Watermeyer, 2012; Peters, 2013; AAAS, 2015; Pew Research Center, 2015; Dudo & Besley, 2016; Guerrero, 2016). An original questionnaire was prepared to address the research objectives of the current study by collecting primary data from scientists.

While developing the survey instrument, various aspects of survey design were considered carefully. It included question formulation/wording, answer options for close-ended questions, length of the survey, number of questions, survey completion time, sequence of questions, and sequence of answer sets. While constructing questions, efforts were made to make questions descriptive and easy to understand (simple and direct) to avoid ambiguity, as the respondents have to answer these without any external assistance. In each question, only one issue was addressed. When there were similar questions or statements, efforts were made to club them into one and use matrix questions. Respondents' views, opinions or agreement to statements in most of the questions were measured on a 5-point Likert scale (Likert, 1932; Edmondson, 2005). A Likert scale has a series of items (a set of responses) indicating agreement or disagreement with the given variable under measurement. The Likert scale is the most popular fixed-format scale where a set of fixed responses is provided for the respondents to choose from to express their opinions (Stangor, 2011). For example, in questions asking the respondents to show their agreement or disagreement to given statements, a 5-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree) is used. In some questions measuring attitudes, a sixth option as 'No Opinion' is also given not to force the respondents to express a view when they do not have any (Bryman, 2012, p.259). For some questions, 4-point scales are used (e.g., Never, Rarely, Occasionally, Often). Some questions provide a list of discrete answers to choose from for the respondents. Details are discussed in the following text.

Most of the questions used in the survey instrument are close-ended ones because such questions 1) help in collecting exact data that is very useful for further analysis, and 2) are easy for respondents to choose from the given set of options/answers then to think and provide an answer, and 3) also save time in filling the questionnaire (Dillman, Smyth & Christian, 2014; Stockemer, 2019).

The content, validity and reliability of the questionnaire were checked and tested by experts in different ways. The first draft of the questionnaire was discussed with the supervisor, DAC members, and other colleagues from science and science communication backgrounds. They were asked to review and provide their comments and feedback on the questionnaire. Based on their suggestions, the questionnaire was modified accordingly to make it more readable, easy, simple, and direct. The questionnaire refinements were done with a focus on how efficiently the questions addressed the stated objectives of the study. Redundant questions were removed. Similar sounding and repeated questions were merged and restructured. The sequence of questions, question-wording and answer options in the close-ended questions were improved to facilitate easy comprehension and quick response. This review, feedback, and refinements in the questionnaire were essential to avoid any errors that could cause respondents to misinterpret a question or its answer options. After refinements and modifications, the instrument was made more compact and focused, ensuring an enjoyable and free-flowing read for the respondents. The questionnaire development exercise and its refinements were executed in several rounds of reviews and revisions during March – September 2018. The questionnaire was tested for its reliability by seeking responses to the online survey. The survey was reviewed, tested, and piloted by 12 scientists, academicians, and researchers known to the researcher and involved in (or familiar with) science communication. Based on the valuable feedback and comments from experts, colleagues, and participants, the questionnaire was further edited and revised appropriately and finalised in consultation with the supervisor.

3.7. The final questionnaire and its structure

The final questionnaire, "Science Communication by Scientists in India: A Survey," consisted of 48 open and closed questions (12 demographic questions and 35 questions based on research objectives). The first item is not a question but an informed consent form requiring the participant to tick it to agree to the terms and conditions for participation in the survey. The final questionnaire is given in Appendix-1.

The survey questionnaire was structured into nine web pages or sections for ease of execution. The first page is about the survey and informed consent, and the second page is on demographics. The 35 research questions were conveniently grouped into the next seven sections. Section-wise details are provided below:

Section 1 – About the survey and informed consent: This introductory section provided information about the survey, potential respondents, voluntary and anonymous participation, data collection and its use for research purposes, instructions, and informed consent. It introduced the participants to the research and its importance and who is conducting this study. The researcher identified himself as a PhD scholar at BITS, Pilani. It was explicitly stated that the survey is part of my doctoral research on science communication by scientists in India. It stated that the potential respondents for this study are the Fellows of the three prestigious national science academies (IASc, INSA, and NASI) living in India. It explained the nature of questions, the number of questions, the structure of the questionnaire, and the tentative time it takes to complete the survey online. They were also informed that participation in the survey is voluntary and that the information provided will be treated as strictly confidential and anonymous with no personal identifier information such as name, email, or IP address will be collected. They were also informed that they could exit the survey at any stage if they felt to do so. Appropriate instructions were provided about how to fill the questionnaire. For any further queries, the researcher's contact details were also provided.

Definitions for this study: Following key terms were defined for an easy understanding for the respondents:

Science communication: Putting in simple terms, it is the popularisation/commonisation of scientific knowledge and practices among the masses (larger society). It is an effort to engage the larger public in science for bridging the gap between science and society. Science communication may include face-to-face interactions and through the use of any possible media or channels of communication.

General public or simply public: The non-specialist adult people outside your research domain. It may include scientists/academics of other fields, politicians/lawmakers, journalists, or anyone on the street who is interested in science.

Scientist: Any person who is actively and professionally engaged in research contributing to the advancement of organised science.

It also included a statement numbered as question 1 (to be ticked) for accepting the terms and conditions of the survey and giving consent for voluntary and anonymous participation in the survey.

Section 2 – Demographics: This web page of the survey included 12 questions (Questions 2-13) seeking demographic information needed for getting a general understanding of who the respondents are and for comparing results from different types of anonymous respondents. It included close-ended questions on gender, age group, educational qualification, type of the institution affiliated with, research experience, publications, learning English, area of research, and Fellow of which academy. There was an open-ended question on current/last affiliation (optional) just if respondents wanted to share which organisation they are/were affiliated with. Another open-ended question required respondents to tell about their mother tongue. One question seeking information on their primary position required them to specify (open text response) if they chose 'Other' from the given close-ended options.

Section 3 – Importance of science communication: This section has five close-ended questions (Questions 14-18) seeking the participants' responses to access their views and attitudes about the importance of science communication. In two separate questions, they were asked to rate the overall importance of communicating science to the general public, and the importance of different ways of communicating science to the public (Face-to-face interactions, TV/videos, Radio, Print Media/Press, and Online) on a five-point scale (Not at all important, Minimally Important, Moderately Important, Important, Very Important). In one question, they were asked to rate how important they thought the given six objectives were to them personally while communicating science to the general public on a 5-point scale where 1 = least important and 5 = very important). The respondents were asked how they would rate the current level of science coverage in the news media in general in India on a scale of (Very Poor, Poor, Average, Good, Very Good, No Opinion). Through another question, they were asked to show their level of agreement/disagreement on a 5-point scale (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) to the given four general statements to assess their attitudes toward science-society interactions making a basis for more public engagement.

Section 4 – Role and responsibilities of scientists in science communication: This section had four close-ended questions (Questions 19-22) seeking scientists' views and opinions on their role and responsibilities in science communication. One question enquires about whether they thought disseminating research results to society was an important part of their current job's roles and responsibilities, just like publishing in peer-reviewed journals. Their level of agreement/disagreement with some statements on scientists' role and responsibilities in science communication was assessed on a 5-point scale (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) through two questions. In another question, they were asked whom they thought should have the main responsibility for communicating science to society from a given list of options.

Section 5 – Scientists' engagement with the general public and the media: In this section (Questions 23-31), scientists were asked about their views, opinion, current practices, and experiences about their engagement in science communication with the general public and the media through nine close-ended questions including three matrix questions. Questions included frequency of individual scientists' active engagement in science communication activities and the frequency of their institutions organising such activities (Scale: Often, Occasionally, Rarely, Never), how often they participated in the given list of such activities in the last year (Never, Once, 2-5 time, 6+ times), how easy/difficult public engagement is for them (Very Difficult, Fairly Difficult, Neutral, Fairly Easy, Very easy), how is their overall experience (Very Bad, Bad, Average, Good, Very Good, No Opinion), how likely they would participate in the future (Very Unlikely, Quite Unlikely, Neutral, Quite Likely, Very Likely), and how they rate their own engagement (Very Poor, Poor, Average, Good, Very Good, No Opinion). They were asked how likely (Very Unlikely, Quite Unlikely, Neutral, Quite Likely, Very Likely) the given six possibilities will happen if you engage in science communication activities through a matrix question. This question was intended to measure the impacts of their engagement. In another matrix question, they were asked to rate their agreement/disagreement (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) with the given three statements about their engagement in science communication with non-specialist publics and the Media. It attempted to assess whether they personally enjoyed their science communication and were confident and well-equipped about their engagement.

Section 6 – Impact of public engagement on scientists' career advancement: This section (Questions 32-34) seeks responses on what scientists think about the impact of their engagement in science communication activities on their career advancement (three close-ended questions including two matrix questions). One matrix question seeks how they agree/disagree with the given four statements about their engagement in science communication with the general public (directly or through the media) and how it impacts their careers (5-point scale: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree). One question seeks how they agree/disagree with the statement that scientists who engage more in science communication are often labelled as 'Publicists' by their peers, which is not good for a scientist's career (5-point scale: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree). In another matrix question, they were asked to rate the importance of three given communication activities for scientists' career advancement on a five-point scale (Not at all important, Minimally Important, Moderately Important, Important, Very Important).

Section 7 – Factors affecting scientists' active engagement in science communication: The eight questions in this section (Questions 35-42) seek the respondents' views on the possible factors affecting scientists' active engagement in science communication activities. Single questions seek responses on how supportive are their institutions, academic colleagues/peers, and family and close friends to scientists engaging in science communication (Not at all Supportive, Minimally Supportive, Moderately Supportive, Supportive, Very Supportive), how frequently their academic colleagues participate in such activities (Often, Occasionally, Rarely, Never), how they agree that many of their institutional colleagues participate in such activities, whether their research is too complex for the public to understand (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree), and how willing they would be to participate in such activities in the next 12 months (Very Unwilling, Quite Unwilling, Neutral, Quite Willing, Very Willing). In a matrix question, they were asked to rate their agreement/disagreement with the given eleven items being potential factors preventing their active engagement in science communication activities on a 5-point scale (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree). Another matrix question explores what scientists think about how skilled they are in communicating science with nonspecialist audiences through different media formats (Face-to-face, Online, TV/Videos, Radio, Print Media/Press) on a 5-point scale (Very Unskilled, Quite Unskilled, Neutral, Quite Skilled, Very Skilled).

Section 8 – Training in science communication: This section with four close-ended questions (Questions 43-46) seeks views of scientists on training in science communication, including how they were ever trained in science communication (choosing the best answer from a given list of options), whether they have enough training for public engagement (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree), whether attending training/workshop on science communication/media skills would improve their public engagement (Yes, May be, No, Don't Know), and whether they are willing to attend any such training/workshops (Very Unwilling, Quite Unwilling, Neutral, Quite Willing, Very Willing).

Section 9 – Enhancing science communication by scientists in India: This section explores what the respondents think is needed to enhance science communication by scientists in India. It has one close-ended matrix question (Questions 47) seeking how the respondents would like to recommend the given eleven interventions for enhancing Indian scientists' engagement in science communication with the public/media on a 5-point scale (Strongly Not Recommended, Not Recommended, Neutral, Recommended, Strongly Recommended). The second question (Questions 48) of this section and the last of the survey is an open-ended (optional) question asking the respondents to tell anything else they think would help enhance science communication by scientists in India.

3.8. Survey execution and data collection

The Fellows of the three academies located at different institutions or organisations across the country were invited through email to voluntarily participate in the study by anonymously filling the self-administered online questionnaire. The email included a link that led them to the online survey questionnaire. The invitation email briefly introduced the recipients to the study exploring Indian scientists' perspectives on science communication and invited them to click the survey link and participate voluntarily and anonymously in the study. Email as the mode of delivering the questionnaire was chosen because email is the most commonly used way of communication among scientists these days. Also, because most internet-based surveys around the world are relying on email as the way of contacting the potential respondents (Dillman, Smyth & Christian, 2014). Email communications allow scientists to see and respond at their own convenience and time, without bothering them much when they are busy. It is a common understanding that almost all scientists have access to PC (desktop or laptop) and smartphones/tabs/ipads, etc. Therefore, using an online questionnaire that works on different devices or screen sizes was an intelligent choice to get responses from the potential respondents. Also, the use of electronic communication and an online survey was helpful to include the scientists (Fellows) who might have retired and may not be attending office at any institution and staying at home or may have shifted elsewhere. Distributing an online questionnaire through email ensures that the recipients do not miss it because of their physical location, and if they are willing to volunteer, they can participate in the study from any location provided they have access to some device (PC/smartphone), email and internet.

All the necessary preparations were done to execute the survey to the selected population of scientists using a professional online survey hosting platform. The final survey was opened for collecting responses during 05-31 October 2018. Three separate email lists of the Fellows of the three national science academies viz. INSA, NASI, and IASc were prepared. Separate email invites having a unique link for the survey to each recipient were sent to the three email lists. The first round of email invites was done on 05 October 2018, with the last date for receiving responses being 15 October 2018 (see Appendix-2 for the original first invitation). Dillman, Smyth & Christian (2014) have suggested that the initial email invitation should be followed up with several email reminders using varying content and appropriately spaced over the field period to increase the number of responses. They suggest that follow-up email reminders should be sent at a faster pace. Therefore, efforts were made to get the maximum possible number of responses by sending three quick reminder emails for participation in the study (see Appendix 3-4), in addition to the original email invitation.

As Dillman, Smyth & Christian (2014) suggested, reminders helped maximise the number of responses. The survey conducted during October 2018 succeeded in collecting 306 anonymous responses from the Fellows of the three national science academies. All the respondents participated voluntarily, and no respondent was paid or offered any incentives for participation in the study. Response rates were calculated academy-wise for total responses (306) as 9.53% for IASc (n = 97), 6.32% for INSA (n = 53) and 11.13% for NASI (n = 156), with the average response rate for the three academies being 8.99% (for details, please see Table 1). This shows that the response rates were very low, as it is one of the main limitations of using self-administered survey questionnaires. These academy-wise responses are the numbers of fellows who responded from that academy's email list. However, many respondents reported that they were fellows of more than one academy. The average time taken by the respondents to complete the survey was about 20-25 minutes.

Except for the optional questions, responses to all the questions and sub-questions were marked as mandatory. An arrangement was made that the respondents could not move to the next page/section of the survey without answering all the questions or sub-questions on the previous page/section. All the questions of each page/section were arranged in a single page view, accessible by just scrolling the page up and down. This 'force response' technique was required to avoid missing data because several statistical analyses cannot be performed with missing data and certain software require no missing data for doing such analyses.

Also, to keep the responses anonymous, no personal identifying information such as email, name, phone number, or IP was collected or linked with the responses. However, necessary arrangements were made to collect not more than one response from each email or IP address.

Table 1: Details about the academy-wise responses and the calculation of response rates.

S.No.	Description	NASI	INSA	IASc
1	No. of Fellows as per the yearbook 2018	1664	931	1077
2	No. of fellows without email IDs in the yearbook	173	32	11
3	Email Bounces as per the survey hosting software	50	28	17
4	Opted out as per the survey hosting software	39	33	31
5	Effective number of fellows = (S.Nos. 2, 3 and 4) subtracted from (S.No. 1)	1664 –173 –50 –39 = **1402**	931 –32 –28 –33 = **838**	1077 –11 –17 –31 = **1018**
6	Total responses (306)	156	53	97
7	Complete/Valid responses (259)	131	49	79
8	Response rate for total responses	156/1402*100 = **11.13%**	53/838*100 = **6.32%**	97/1018*100 = **9.53%**
9	Average response rate for 3 academies (total responses)	(11.13% + 6.32% + 9.53%)/3 = 26.98%/3 = **8.99%**		

3.9. Analysis of survey data

Out of the 306 responses collected, 259 complete and valid responses were selected for this study and further analysis. The survey data were exported to MS Excel for further statistical analysis, data cleaning, numerical coding, tabulation, summarisation, and visualisation for interpretations. Data cleaning, refining, and numerical coding were done manually by the researcher. The survey data were statistically analysed by using MS Excel, JASP, and SPSS software. It included descriptive statistics, percentages, frequencies, means, medians, and standard deviations. One-way ANOVA tests were used, where needed, to analyse statistically significant differences between the means of different groups. Eta squared ($\eta 2$) value is used to measure the effect size in ANOVA models, where $\eta 2 = .01$ is small, 0.06 is medium, and 0.14 or higher is large effect size (Zach, 2020). Regression analysis models were used to determine any predictive values. Chi-Square (χ^2) test and Pearson correlation coefficient (r) were used to analyse any differences/associations between different variables. Effect sizes for describing the magnitude of association in Chi-square tests are measured by using Cramer's V values, where value ≤ 0.2 is weak, 0.2-0.4 is moderate, 0.4-0.6 is relatively strong, 0.6-0.8 is strong, and 0.8-1.0 is very strong (Rea & Parker, 2014, p.219). Reliability analysis (Cronbach's Alpha) was used for testing scale reliability. For calculating high importance or agreement percentages, only the responses in levels *'4'* and *'5'* on the 5-point scale were used. Statistical significance was determined by a p-value of < 0.05. Details are provided in Chapter 4 on Results and Data Analysis.

3.10. Limitations of the research method

Like every research method, survey methods also have their limitations. Online questionnaires have several advantages, such as reaching a large number of potential participants across institutions at different locations in a short time without visiting them personally or physically and collecting data electronically. Surveys eliminate interviewer effects and social desirability bias (Bryman, 2012; Bradburn, Sudman & Wansink, 2004), leading the respondents to even report the negative things more freely compared to interviews. In the personal absence of any interviewer or data recorder, the respondents are relatively at more ease and comfort to express their own natural mind without any filters. It allows accessing people who are otherwise not easily accessible. The respondents can participate in the study in a self-controlled and self-administered online interview at their own convenience and take their own time and thinking to complete the survey. Compared to other modes of survey such as face-to-face interviews, online questionnaires are cost-effective. There are limitations as well. One limitation of online questionnaires is that these are self-administered and self-reported without any external assistance, so the quality of data collected depends on the instrument's reliability and the serious and honest reporting by the respondents. As there is no interviewer involved, the questionnaire instrument must be easy to follow, having questions easy to answer (Bryman, 2012, p.233). Otherwise, respondents may get fatigued and can exit the survey. Therefore, such surveys cannot have too many questions, especially open-ended ones. Close-ended questions with pre-coded answers as in Likert scales make surveys attractive and easy to complete for respondents. In close-ended questions, it is easy to record, process, and compare answers while also reducing possible variability in recording answers, as in the case of open-ended questions or interviews (Bryman, 2012, p.250). One of the main limitations of self-administered surveys is the low response rate. Another limitation is that more respondents might be those who are already interested in or working on the topic of the research. This may lead to a positive bias in the sample. To ensure the instrument is reliable, it was reviewed and tested by senior members of the scientific community. The questions in the instrument were structured in such a way that there is no incentive or assumption of encouraging respondents to give positive or negative responses. Another limitation is that these cannot be executed without access to the internet and email. Technical issues in accessing the internet and email may discourage participants from completing the survey. Also, as there is no personal presence of the interviewer or data recorder, the respondents are at more liberty to exit the survey at any time without completing it, and the researcher has no control over here. As the researcher cannot access non-verbal cues and do further probing, the data quality depends on how well the questionnaire instrument is prepared.