Scientific social responsibility – A systematic literature review

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ABSTRACT

Scientific Social Responsibility (SSR) concerns the development of synergies between all players of our scientific knowledge community, as well as the creation of ties between science and society. The contribution of SSR compared to corporate social responsibility (CSR) is minimal at present and not well documented in the literature. The purpose of this paper is to present a systematic literature review of SSR. The components were identified through detailed study of literature from year 1947 to 2019 from various fields in order to evaluate SSR. The scope of this paper is to provide a broad overview and clarity to the topic of SSR. The paper also exclaims the draft policy implemented by India and how it aids in betterment of society.

Keywords: *Scientific Social Responsibility (SSR), Scientific Community, Corporate Social Responsibility (CSR), Draft Policy, Higher Education Institutions (HEI's).*

1. INTRODUCTION

Any significant changes that occur in science will have a substantial influence on society. Most of the research activities in the science & technology sector are implemented with public funds; it is true, especially in a developing country like India. The entire science community needs to have a higher moral and ethical commitment to contribute to the public. Scientific Social Responsibility (SSR) is all about the co-relation of society's contribution to science and the scientific community's contribution to society. It is impossible for the scientific community to avoid a relationship with society.

According to the SSR policy drafted by the Department of Science & Technology (DST), Government of India on 9th September 2019, SSR will refer to a junction where a scientific community with inspired leadership meets social morals and ethics. It results in the strengthening of knowledge and increasing the capability of science for the usefulness of society. It is also concerned about strengthening relationships between all science community stakeholders, and establishing a link between society and science, thereby broadening science and its advantages to society. It helps young minds to build and nurture an interest in science. The contribution of SSR compared to corporate social responsibility (CSR) is minimal at present and not well documented in the literature. The reason may be, in most of the countries, there is no SSR policy or compulsion. Realizing the importance of SSR, the Indian government will soon release SSR policy and guidelines and activities similar to CSR to promote the SSR activities in Indian academic Institutions (Arora, 2019).

Academic institutions are giving more attention to the programs in demand and economically viable. On the other side, the decrease of attention on environmental matters and socially relevant programs could be visible in the present context. One of the reasons may be, the Higher Education Institutions (HEIs) are evaluated based on their offerings for economic development and expansion, rather than their volume of contribution towards societal need. HEIs will play a crucial role in development (social and economic), human rights, culture, and research and imbibing morality and ethics. Many students will enroll in HEIs as it helps them gain more

knowledge and skill. It will aid students' way of processing, evaluate information, and conduct themselves to be better community members to contribute to society. Every year, 1.5 million engineers will graduate worldwide (Wikipedia), and how many of them contribute to society's betterment?

Numerous science fairs are conducted worldwide to understand the implication of science and technology and motivate and nurture young science aspirants. Few among them are the North Carolina Science Festival, Edinburgh International Science Festival, Intel International Science and Engineering Fair. In India, institutes like the Indian Institute of Science, Bangalore, organizes the "OPEN DAY" event every year to showcase its science activities to the student community and the general public. It was conceived as a day on which industrialists and students can visit departments and seek technical advice and know-how. The first-ever Open Day, as we know it today, was held on 3rdMarch 1977. These activities can be labeled under SSR as they create awareness about the latest innovations and achievements related to science and technology, leading to society's betterment and increasing scientific knowledge to the general public.

SSR activities will also create an environment for scientists to share their knowledge among themselves and to the public by writing blogs, publishing articles, research papers, and others, or through other modes. This kind of activity will make them work closely and results in higher values. In developed countries like the USA, Japan, and many more, industries have tie-ups with universities, which help them convert their prototype projects into real-time projects. In a few developing countries like Brazil, South Africa, India, there is not much exposure to this relatively new SSR concept, so comparatively, there is less contribution to socially beneficial activities. So, India has a plan to introduce a policy on SSR. If this proposed policy is successfully implemented, India will be the first country to show the way for the rest of the world.

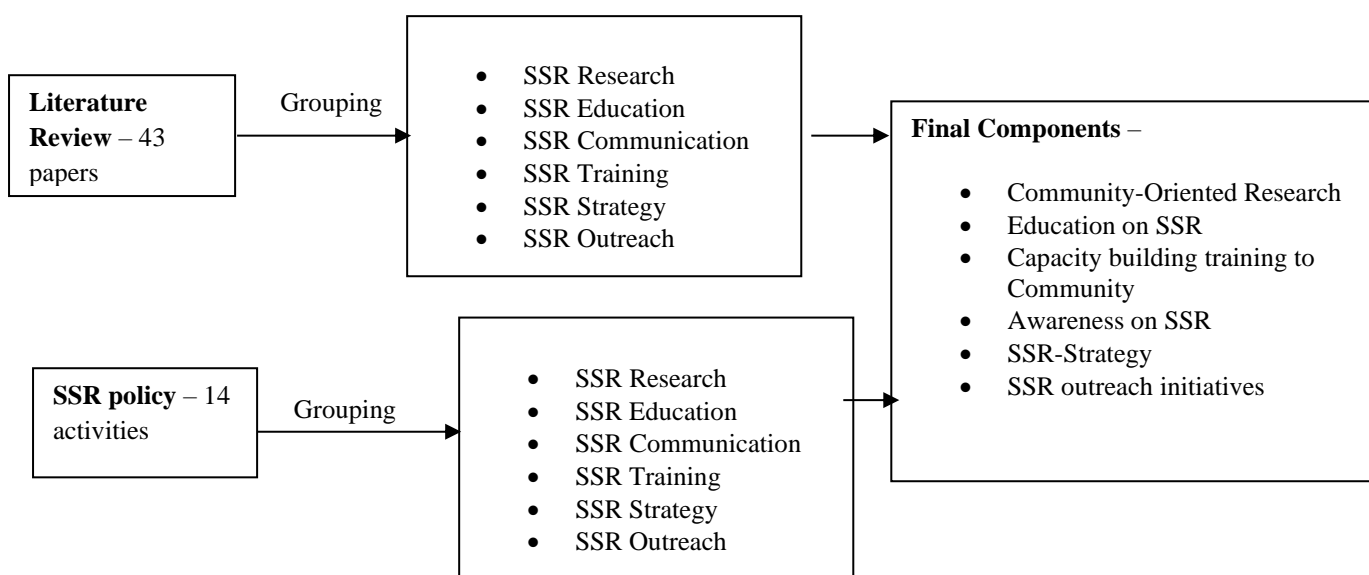## 2. RESEARCH METHODOLOGY
2.1 Search Process
  The review started by scanning for appropriate research studies on various databases. The search terms that were used are "Scientific Social Responsibility", "Science and social Responsibility" and "Social Responsibility of Scientists". The searches were run against the keywords, abstract and title on the mentioned search platforms. The review was started on 20th September 2020 and considered all studies that had been published up to this date.

2.2 Research Selection Criteria
There are minimal works on Scientific Social Responsibility. Papers were considered from year 1947 to 2019 from various fields. Articles written in Non - English language were not considered.

2.3 Selection Results
Total of 43 papers were selected, which fulfilled the search criteria, and they were thoroughly studied. From the study, papers were categorized according to their outcomes and arranged in chronological order. Pareto analysis was carried out to identify the vital components that contribute more towards SSR.

Fig. 1: Block Diagram of Research Methodology

3. LITERATURE REVIEW
Scientific Social Responsibility (SSR) aims towards the betterment of society through scientific research and other socially relevant activities. The scientific community's commitment is to be aware of its implications on society's decisions and activities with a clear and moral behavior, so it paves the way to viable and sustainable development.

Upon reviewing the field of SSR state in the academic sector, it could be understood that the concept of SSR is still in the infant

stage, and it is being implemented in an informal way. This literature review aims to evaluate the SSR initiatives undertaken by various researchers across the globe and strengthen science and society linkages. SSR is a relatively less explored subject. This literature accumulates information from various research conducted in different fields.

Table 1: Literature Review

Author	Objective	Methodology	Outcome	Indicators
Bridgman (1947)	To establish Scientific methods in science for which discoveries can be used.	Definition Article	Determines the limit to which Scientific discoveries affect society.	Scientific methods to analyze the innovation made in science
Rip and Boeker(1975)	To increase awareness about the systematic review of social responsibility in the field of science.	Analytical Article	Expands the social responsibility conscious among the scientists	Study of science policy, social history, and sociology of science.
Cross and Price (1991)	The necessary skills for citizens to participate in issues surrounding science implications on society.	Survey of Science-Technology-Society (STS) movement	Probes the socially responsible science education by observing the trends in Science, Technology.	Finding the limitations in the STS movement
Brunner and Ascher (1992)	To examine the role of science in worldly affairs and improve the accountability of science to society.	Design Of questionnaire in the social context	The primary purpose of scientific knowledge is to make scientific predictions and improve science's scientific responsibility.	Problems faced while improving the overall social responsibility of science to society.
Ramsey (1993)	To establish social responsibility as a primary educational goal.	Meta-cognitive issue analysis	The STS provides the basis for meeting the obstacles faced by science in formal education.	Role of social responsibility in science education
Youniss and Yates(1997)	To instill social and moral responsibility in adolescents through communal service.	Case study	Simulates the ethical and social behavior in adolescents	Benefits of performing community service
Berman (1997)	To nurture the topics which concernthe social responsibilities of a child's consciousness.	Compare and contrast individuals	Generates the awareness of social responsibility at a young age	Development of socialresponsibility in a child's consciousness
Clifford(1998)	To expand the human understanding of the current environmental conditions through social-science programs.	Case study	Develops a better understanding of the current environmental state in a social-science context.	Understanding the present ecological conditions
Recher and Ehrlich (1999)	To participate in the scientific process and communicate the research to the public	Survey methodology	Application of scientific outcomes has to benefit society to be funded by any authority.	Communicating and sharing research
Pedretti (1999)	To teach young students about science in a social context through Science Technology, Social (STS) education.	Case study and Issue-based approach	Understanding the intricate correlation of social responsibility and scientific knowledge.	Moral Reasoning Decision making
Fleischmann (2000)	To view the topic of SSR in terms of paradigm driven cases such as cold fusion.	Case study	Reviews the Sociology of Science and Social Responsibility in Science concerning the subject "Cold Fusion."	Cases involving paradigm scientific research
Francis (2001)	To establish an equilibrium between health care responsibilities and the necessary societal changes by the medical professionals	Case study	The balance between the Medical Ethos and Social Responsibility in Clinical Medicine.	Current practiced standards of medical professional
Weil(2002)	To give the required attention to the ethical issues faced in the practice of science.	Leitner's analysis	Scientists have given the foundations and scope of the scientific community's responsibilities in society	Set standards of ethical responsibility in the scientific community
Weed and McKeown (2003)	To collect scientific knowledge from the medical professionals that concern the public health and its	Case study	Medical professionals' social responsibility aims to maintain a reliable,	Moral responsibility of health researchers Ethical practices in public health

	applications in public health practices		professional trademark with an ethical mindset.	
Beckwith and Huang (2005)	To ensure that modern society remains in line with the rapidly evolving technologies.	Analytical article	A better understanding of science and its implication by scientific community to avoid any major crises due to science	Scientists responsibility for public discussion
Hansen (2006)	To establish a relation between the ethical values of science and the individual roles of a scientist.	A systemic model of the relationship between the ethos of science and science's social institutions	Scientists are responsible for producing credible and transparent scientific knowledge without any external interests.	Ethics of science
Delandshere(2007)	To examine how scientific research impacts public well-being.	Case study	Scientific research communities are responsible for notifying society about the latest policies and their benefits.	Literacy research Social Ethics
Zandvoort (2008)	To prepare engineers for SSRby Higher education institution (HEI) with consideration of social, organizational, and political context	Questionnaire on ethical analysis	Engineers work to reveal macro or micro level ethical issues and tovalidate the possible solutions.	Macro and micro ethics
Bybee (2008)	To ensure the full involvement of science in citizen's lives through scientific literacy.	Structured questionnaire	Program for international student assessment (PISA) aims to increase the scientific literacy of society.	Study on the literacy rate of society about science.
Conlon (2008)	To find adequate characteristics to produce socially responsible engineers.	Comparative study of engineers	A makeover of the engineer's potential to reinforce social responsibility.	Engineering Ethics Employability
Rhodes and Sulston (2009)	To explore the significance of scientific responsibility with respect to overall global development.	Definition article	Provides essence of scientific social responsibility with context to global development.	Scientific social development factors
Holbrook (2009)	To vitalize the proposals related to science and technology education.	Case study and Issue-based approach	Perceives that science and technology education must make viable progress and recognize learning issues.	Sustainable development for education
Marinescu et al. (2010)	To create a high level of awareness about involving members of science in solving social problems.	Case study	Clarifies the scientific, social concept and presents us a case study of the initiatives taken by the University of Bucharest	Clarifies the concept of SSR with the help of a case study
Walter and Richards (2011)	To make the scientists accountable for up skilling the people about science through scientific declarations.	Data Analysis	Scientists are liable to educate society about science.	Well-defined statements of science Accessibility of science to the public
Larsen et al. (2011)	To drive SSR into a brimful bloom and to recognize scientist's efficiency of energizing collective efforts.	Review article	Universities should be given the power to focus on obtainable capital for insightful researches.	Societal Challenges
Zoller (2011)	To endeavor for sustainability in Science-Technology-Environment-Society (STES) interfaces.	Evidence-based research	STES related research in science education focuses on tertiary and secondary education.	The paradigm shift in education, research, thinking, and conceptualization
Rusli(2012)	To create an empirical prototype for handling day-to-day affairs with science and engineering	Study based approach	Focuses on science and scientific awareness through fundamental physics lectures.	Scientific literacy Science Awareness

Díaz et al. (2013)	To propose a model that links the sequence of Research–Development–Innovation in nanotechnology to social responsibility.	Clarkson scale	Describes the extrinsic and intrinsic factors of imposition at the research hub of Nano-engineering industries.	Internal and external connotations
Zandvoort et al. (2013)	To provide the education necessary for teaching social responsibility to engineers and future generation scientists.	Case study	Cultural change and educational activists contribute to teaching social responsibility to students of science and engineering.	Teaching perspectives
Dima et al. (2013)	To propose a social responsibility model in universities based on the six dimensions of a literature review and content analysis.	Ordinary least Squares (OLS)	Generates the concept of Academic Social responsibility based on Corporate Social Responsibility	Academic responsibility
Glerup and Horst (2014)	To understand the correlation between the scientific debate and policy-decisions taken.	Design of the questionnaire	The framework to map scientific social responsibility activities and re-establish with social benefits.	Mapping and connectivity of scientists
Eliasa (2014)	To design a game for refining cooperation and the social ability of the students to exercise communication.	Collective study of social activities	Increases the values of teamwork and coordination of students through games, which unites Education essence in Lectures.	Values of Teamwork and responsibility
Frazer and Kornhauser(2014)	To develop science and technology education with a context of ethical responsibility.	Case study analysis	Implants the concepts of ethics in science education.	Ethical practices in science and technology education
Lewis and Kelly (2014)	To address the future needs of humans through science and technology education.	Predictions	Directs the field of science and technology towards future requirements of humans.	Ensuring the future societal needs are met
Sankar and Cho (2015)	To conduct experiments through CRISPR-Cas9 tool for reviewing previous policy on bioethics in science and advising about SSR.	Experimental study	Provides a structure to review the policies on bioethics	Ethical policies on genetic engineering
Canney and Bielefeldt (2015)	To provide a framework to ease the establishment of personal and professional social responsibility in engineers.	Qualitative Data Analysis from interviews	Proposes a blueprint and Professional Social Responsibility Development Model (PSDM)	Developmental Framework
Conley et al. (2015)	To define the concepts of SSR and to incorporate the lessons from the CSR movement	Case study	Describes the lessons of CSR Movement, which can be integrated into SSR movement.	Corporate activities
Gurel (2016)	To educate about the Pre-Service-Science-Teachers (PSST) program and carry out a scientific demonstration to young children.	Case study	Promotes the concept of science in elementary school children using everyday materials	Scientific presentations
Vázquez.et.al (2016)	To analyze the impact of University Social Responsibility (USR) from a student' point of view	Survey	Student's contentment is requisite to attain the objective of higher educational institutions by focusing on antecedents of students.	Perception Satisfaction
Saguy(2016)	To ensure SSR becomes an essential dimension in academics and industry collaboration.	Black-box approach	SSR should become a daily habit in an engineer's practice.	Challenges and opportunities in food engineering
Meloni and Muller (2018)	To explore epigenetics in environmental exposures and life experiences through SSR	Case study	Interdisciplinary discussion and collaboration is crucial for epigenetic inheritance	Epigenetics of Social Adversity

			with subject to society and science	
Rajput (2019)	To educate society about the Indian draft policy on SSR and strengthen its knowledge ecosystem and convert scientific research into social benefits.	Definition Article	Policy on SSR is drafted for the benefit of society.	Draft Policy of India on SSR
Arora(2019)	To gather the public and scientific community's opinion on implementing SSR policy in India.	Definition Article	Ensures successful implementation of SSR policy for the benefit of society.	Draft Policy of India on SSR

From the above literature review, it can be inferred that many authors have explored the relationship and impact of SSR on scientific community and have played a major role in the body of literature. From the pragmatic researches, it is observed that scientific community and their participation plays a crucial act in any kind of social activities. Authors have examined the effects of SSR on scientific community, in task domain by considering student-linked activities such as science fair exhibiting latest technology, blogs and articles on scientific research which impact society, mini-science project which helps in development of rural areas, research thesis which enables sharing of knowledge among the scientific community and so on… all these activities are essential to establish the welfare of society and brings harmony between scientific community and society. All these activities which contribute to societies benefits can be categorized as SSR.

From Table-1, it is apparent that many researchers have analyzed the differences between SSR and Corporate Social Responsibility (CSR). SSR focuses on responsibilities of scientific community to benefit public while CSR focuses on responsibilities of corporate community to benefit public which in return helps in economic development. SSR emphasizes on scientists, researchers and HEI's contribution. Scientific community's contribution can be comprehensively termed as Scientific Social Responsibility (SSR) which enhances the societal-life satisfaction by providing favorable innovations and technologies. A study revealed that young students has to be taught about science in social context in the field of Science, Technology, Social (STS) education, aid in understanding the intricate correlation of social responsibility and scientific knowledge (Pedretti, 1999). This is because it is vital for young children to accumulate themselves with the art of innate query, pedantic thinking, decision capability about science knowledge and their interaction with the society.

The Table-1 is arranged in chronological order, ranging from 1947 to 2020 across the globe in various fields such as education, health, universities, economic. Some of the factors which are used for analyzing the SSR activities are: Through providing access to science and technology infrastructure to public, Demonstration of technology, Scientific solution to local problems, betterment of rural innovations using science, conducting workshop on SSR, FAQ's containing information on common scientific solution, awareness through lectures and mass-media, induction through internship. SSR activities aids in nourishing science-society bonding in a natural way by establishing harmony among all the contributors so as to steer in a cultural reform in the behavior of science for the welfare of society (Arora, 2019). The research articles published by various researchers in different SSR components from 1947 to 2020 are presented in the Table- 2.

Table 2: SSR component and Articles

S no.	Category	Papers	No. Article
1	SSR- Research	Bridgman (1947), Ripand Boeker (1975), Clifford (1998), Weil (2002), Weedand McKeown (2003), Beckwithand Huang (2005), Delandshere (2007), Bybee (2008), Rhodesand Sulston (2009), Walter and Richards (2011), Diaz et al. (2013), Meloniand Muller (2018)	12
2	SSR - Education	Cross and Price (1991), Ramsey (1993), Pedretti (1999), Francis (2001), Holbrook (2009), Zoller (2011),Zandvoort et al. (2013), Dima et al. (2013), Frazer and Kornhauser(2014), Lewis and Kelly (2014), Vazquez et al. (2016)	11
3	SSR-Training	Berman (1997), Hansen (2006), Zandvoort(2008), Conlon (2008), Eliasa (2014)	5
4	SSR- communication	Recherand Ehrlich (1999)	1
5	SSR- Strategy	Brunner and Ascher (1992), Fleischmann (2000), Marinescu et al. (2010), Larsen et al (2011), Glerupand Horst (2014), Sankarand Cho (2015), Canney and Bielefeldt (2015), Conley et al. (2015), Rajput (2019), Arora (2019)	10
6	SSR-Outreach	Youniss and Yates (1977), Rusli (2012), Saguy (2016), Gurel (2016)	4

SSR was a primary concern in the field of scientific research; many authors have highlighted the significance of SSR in the scientific community, especially the role of each scientist to uphold the moral values and ethical standard in their field of research, with Bridgman being the first to notice the necessity of SSR in Research and most works related to SSR are done in this field, next is the field of education, where authors such as Cross and Ramsey specified the importance of STS education and establishing SSR as an educational goal to make students morally responsible, SSR training refers to specific programs which create awareness about SSR and also train people to be socially accountable, SSR Communication refers to sharing of scientific research, which benefits the

society (Recher,1999). Authors like Glerup and Arora have provided us with a framework to develop a model of SSR. Finally, SSR outreach talks about the programs conducted for the overall development of a nation. Further, the Indian draft policy had identified various social relevant activities, these activities are grouped again with the categories, are shown in the Table-3.
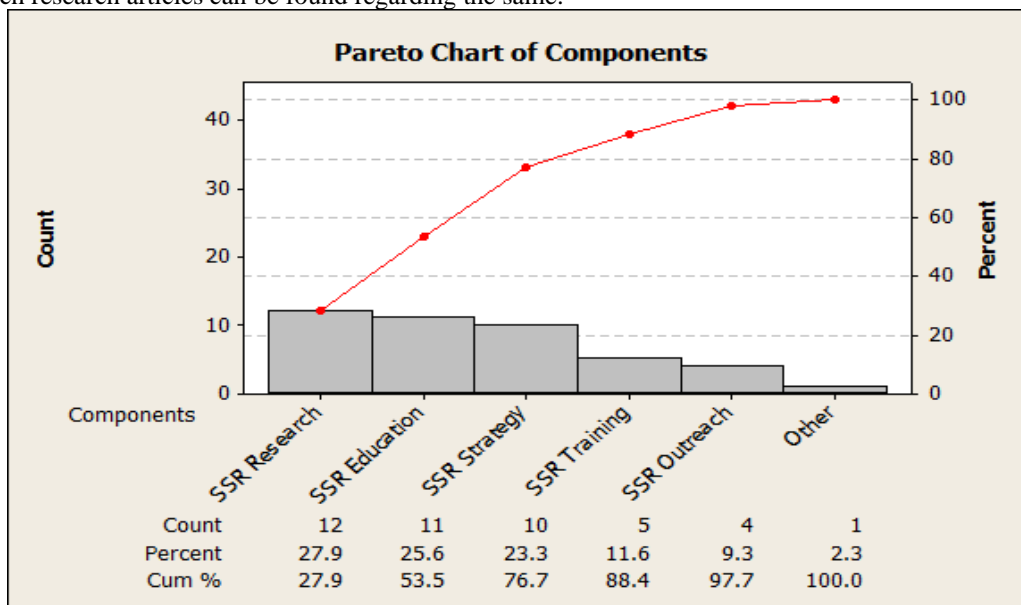
Table 3: SSR activities under various SSR Groups.

S no.	Components	Activities
1	SSR- Research	• Providing access to S&T infrastructure to outside researchers through College and university teachers. • Scientific solutions to local problems by multidisciplinary teams and environmental engineers.
2	SSR - Education	• Awareness through lectures for schools, colleges, and NGOs. • Teaching by scientists in courses and a series of the lecture.
3	SSR-Training	• Demonstration of technologies in exhibitions, fairs, institutions. • Sensitizing workshops on SSR in Institutes and R&D organizations. • Induction through an internship in National laboratories for UG students, PG students, and doctoral scholars. • Skill development through training and workshops for college students, women, local bodies, teachers.
4	SSR- Communication	• Developing apps on SSR • Awareness through Mass media and social media such as TV, FM, Newspapers, magazines, YouTube, Whatsapp, and Twitter.
5	SSR-Strategy	• A framework of action plan such as policy.
6	SSR - Outreach	• Betterment of rural innovation using science by providing scientific input and necessary facilities. • FAQs are containing information on common scientific solutions through instructional videos and local language brochures. • Mentoring of school students by scientists/ professors for innovative projects.

The table 3 shows how the six SSR categories can be considered for implementation in India (Arora, 2019). SSR research can be made easier if there access to S&T infrastructure and also by providing the scientific solution to problems plaguing our society, SSR education through awareness and teaching programs, SSR training by the demonstration of latest techs and skill development programs, Improving SSR communication by developing apps for the sole purpose of generating awareness and easier facilitation and using mass media outlets. Drafting an action plan with set objectives to achieve SSR goals and conducting SSR outreach programs for rural betterment through science innovations and encouraging science projects helps resolve society's problems. Again these categories are analyzed with pareto to find out the predominant category.

4. IDENTIFICATION OF VITAL SSR FACTORS USING PARETO ANALYSIS

Pareto analysis is a very simple and easy technique for decision making that follows the 80/20 principle, where 80% of the factors are vital and the other 20% are considered useful by other researchers. Using Pareto analysis, few major SSR factors were determined based on which the researchers have framed their research work. For this purpose, research papers were collected and analyzed from various database references and various others by using the key terms such as SSR, social responsibility, social responsibility with connection to engineering, academics, ethics, science, bio-technology, mapping, etc. and this resulted in 6 factors of SSR considered by various researchers as listed in Table-2 and Table-3. The numbers of factors determined are limited as SSR is a relatively new field and not much research articles can be found regarding the same.

Pareto Chart of Components

	SSR Research	SSR Education	SSR Strategy	SSR Training	SSR Outreach	Other
Count	12	11	10	5	4	1
Percent	27.9	25.6	23.3	11.6	9.3	2.3
Cum %	27.9	53.5	76.7	88.4	97.7	100.0

Fig. 2: Pareto Chart of Component

Based on frequency of consideration by researchers, 6 SSR factors were identified for study and are based on frequency of considerations, cumulative frequency and percentage of cumulative frequencies are calculated and is mentioned in Table- 4.

Table 4: Frequency of SSR components

Components	Frequency of consideration	% of Frequency consideration	Cumulative frequency	Cumulative%
Community-Oriented Research	12	27.9	12	27.9
Education on SSR	11	25.5	23	53.4
Capacity building training to Community	10	23.3	33	76.7
Awareness on SSR	5	11.6	38	88.3
SSR-Strategy	4	9.3	42	97.6
SSR outreach initiatives	1	2.4	43	100

Based on researchers' frequency of consideration, 6 SSR Categories were identified. They are SSR Research, SSR Education, SSR Training, SSR- Communication, SSR Strategy, SSR outreach. These categories renamed as Community-oriented Research, Education on SSR, Capacity building training to Community, Awareness on SSR, SSR-Strategy, and SSR outreach initiatives.

4.1 SSR - Research
SSR-Research deals with the scientific community's social responsibility and individual scientists to uphold ethical and moral standards in their respective research work. Understanding society's needs and solving the same through scientific research is essential for the nation's sustainable growth. It requires a close relationship between the scientific community and society.
Scientists are socially responsible for their discoveries and must foresee their end uses made by society. During the Second World War, mainly before Hiroshima's bombing, scientists were not conscious of their invention's application (Rip, 1975). After seeing the fatalities caused by some of the discoveries, the Nobel laureate Bridgman felt that the scientific community had to come together, rethink the findings' applications, and ensure such hazardous events would not occur sure their discoveries aid society's betterment. As the relationship between society and science becomes complex, scientists' moral responsibility becomes of the utmost importance (Bridgman, 1947). The scientific community needs to work closely with society, understand its problems, and try to deliver appropriate solutions through its research initiatives. The researchers also stressed the importance of social responsibility in their field of research.

4.2 SSR - Education
The significance of teaching social responsibility to stakeholders so that they incorporate those values in their future work field is of utmost importance to set up SSR as one of the educational goals.The coverage of SSR in education is essential, and it can influence the individuals throughout their professional life. It can be examined by studying the trends in science, technology, and social (STS) movements (Cross 1991).Academic institutions of various levels worldwide need to establish social responsibility as a common educational outcome among the student community irrespective of their study stream (Ramsay 1993). The significance of an issue-based approach to learning STS education is vital in the present context (Pedretti 1999). All the mentioned researchers have critically examined the importance of including social responsibility knowledge in schools and universities and stressed its importance. Teaching programs for students should be supplemented by courses that illustrate the importance of scientific social responsibility. The students and scientists must follow an interdisciplinary research approach to solve complex societal challenges (Larsen,2011).

4.3 SSR- Training
The capacity-building activity for society's empowerment, using the various resource of the academic organization, is the need of the day. It also builds confidence and relationship between the community stakeholders and the Institution. The SSR training refers to specific training programs oriented towards generating awareness about SSR, Skill training, and other need-based programs for society's socially deprived section. Training the school/college dropouts and unemployed graduates with scientific skills to benefit society can be labeled as Scientific Social Responsibility training. It is all about empowerment of socially deprived class by providing need-based training for their socio-economic empowerment. Training the stakeholders of the society with technical skills is most in this era of booming technologies. It is necessary for all levels, irrespective of age and qualification. Programs can be designed based on their knowledge, area of interest, and needs of the society. So, the institutions can take up the initiative to train the needy stakeholder's society with few science-oriented skills, increasing employability and benefits the community as a whole.

4.4 SSR - Communication
Communicating scientific research outcomes to society are significant for society's betterment, and Recher describes the importance of disseminating research to the public. The significance of communicating scientific research results with the rest of the world is of utmost importance as scientific research is not an individual's discovery but part of the science ecosystem (Recher, 1999). Institutions also play a vital role in conveying the importance of communicating scientific research and other SSR activities to their stakeholders. The scientific community has to highlight the significance of sharing its research, which is beneficial for society.

4.5 SSR -Strategy
SSR-Strategy refers to a plan of action to implement SSR through policies and frameworks. Strategies to implement for SSR have become an agenda for many nations to meet today's global challenges. To bring this to reality, academic institutions need to have their strategy and align with the national strategy. It can be implemented in many ways; for example, funders may make SSR a requirement for providing grants (Rajput, 2019).SSR policy needs to be implemented to give back to society in return for the

taxpayer's funds, supporting their research. Researchers need to follow fixed guidelines mentioned in the policy for better results (Arora,2019).

4.6 SSR - Outreach
SSR outreach refers to activities undertaken by various institutions to reach society. Programs of creating awareness and community services in rural areas to educate the rural people about science innovations and technologies can be identified as SSR outreach. Community services should aim to develop consciousness of SSR and find solutions for community problems. Also, Youth participation plays a significant role in solving social issues and promoting the outreach program (Youniss, 1977). Scientific communities can take up the responsibility to conduct outreach programs in rural areas, to develop the rural areas technologically.

5. CONCLUSION
Higher Education Institutions are mainly into teaching and research, but only a few research outcomes are commercialized, compared with industrial research. It may be because institutions' primary activity is not scientific research. Even though research studies are conducted, their direct relevance to society is questionable. In the present context, for a higher level of effectiveness and society's benefit, the institutions need to work closely with the community by understanding each other.

In the research field, the outcomes are only documented but not made available to the public in most cases. Generally, research outcomes do not benefit society directly. The SSR activity's primary purpose is to eliminate this gap and ensure that society benefits from all its scientific activity.

In a global context, the USA, UK, and Romania have defined SSR's concept but seems to be underdeveloped and must be redefined through a policy that no country has done at present. The reasons for this may be several; namely, the government and non-government agencies providing the research grants to the scientific community emphasize more on effective utilization of funds, infrastructures facilitated, articles published, patents, and others. The funding agencies must bindthe scientific community to expect the researchers/scientists to strive hard to ensure that potential innovation and research results will be of societal relevance. The funded organization has to take up the initiative to document their activities. It leads to several new concepts that not only create awareness, also help to solve societal problems. The level of understanding and activities between the scientific community and society may differ based on the stakeholder's interest and policy.

For example, in today's pandemic situation, there is an increasing demand for the scientific community to make potential discoveries to prioritize and carry out outreach activities for the benefit of the human community. These initiatives from the scientific community can result in gaining the trust of society. Hence, there is a need for scientific institutions to assume responsibility to derive the research outcomes with due considerations for regaining society's trust. The research results need to be channelized towards solving the community's vital problems, linking science & technology innovations to society. It is of utmost importance, and it improves the standard of living. It also aids in closing the gap between the scientific community and societal needs, enhancing the image of all the stakeholders.

The concept of SSR could be traced back to 1947, where Bridgman had defined SSR has the responsibility of scientists for their discoveries to society in the USA (Bridgman,1947). Ramsey had signified the importance of establishing SSR as a major educational goal globally, with universities playing a vital role in generating awareness about SSR and preparing its respective stakeholders on SSR guidelines(Ramsey,1947).In his article, Pedretti had stated that students have to be taught about Science & Technology in a social context(Pedretti,1999). In the same line Richards in 2011, had conveyed the moral responsibilities of scientists towards society, being accountable to provide credible scientific information to upskill the people. Apparently, in 2015, Canney had argued that the focus on employability alone is not sufficient to produce socially responsible students but should also provide a framework to understand personal and professional responsibility with special attention on social responsibility. According to Conley (2015), Scientists must incorporate the lessons of SSR from CSR to drive SSR into a brimful bloom. But it can be noted from the literature that no systematic study was implemented to evaluate SSR activities in both Indian and global contexts.

In the Indian context, the government has taken up the initiative to bring a national policy on SSR. and had released a draft policy. This policy can provide useful insights to improve the scientific contribution to societal development. If the policy is implemented successfully, India will be the first country to have an SSR policy (Rajput, 2019). SSR policies will help strengthen science - society linkages and make the science and technology ecosystem vibrant. The scientists will get an opportunity to contribute to society as a repayment to the taxpayer's money and also satisfies the scientific community's ethics (Arora, 2019).Based on researchers' frequency of consideration, six SSR Categories were identified. They are SSR- Research, SSR –Education, SSR-Training, SSR-Communication, SSR-Strategy, SSR outreach,These categories renamed asCommunity-oriented Research, Education on SSR, Capacity building training to Community, Awareness on SSR, SSR-Strategy, SSR outreach initiatives.

6. ACKNOWLEDGEMENT

7. REFERENCES
[1] *Arora 2019 SCIENTIFIC SOCIAL RESPONSIBILITY (SSR) POLICY.pdf*. (n.d.).
[2] Rajput, A. S. D. (2019). India aims for national policy on scientific social responsibility. *Nature*, *574*(7780), 634. https://doi.org/10.1038/d41586-019-03294-w

[3] Meloni, M., & Müller, R. (2018). Transgenerational epigenetic inheritance and social responsibility: perspectives from the social sciences. *Environmental Epigenetics*, *4*(2), 1–10. https://doi.org/10.1093/eep/dvy019

[4] Saguy, I. S. (2016). Challenges and opportunities in food engineering: Modeling, virtualization, open innovation and social responsibility. *Journal of Food Engineering*, *176*, 2–8. https://doi.org/10.1016/j.jfoodeng.2015.07.012

[5] Vázquez, J. L., Aza, C. L., & Lanero, A. (2016). University social responsibility as antecedent of students' satisfaction. *International Review on Public and Nonprofit Marketing*, *13*(2), 137–149. https://doi.org/10.1007/s12208-016-0157-8

[6] Gurel, D. K. (2016). The effect of science demonstrations as a community service activity on pre-service science teachers' teaching practices. *AIP Conference Proceedings*, *1722*. https://doi.org/10.1063/1.4944206

[7] Canney, N., & Bielefeldt, A. (2015). A framework for the development of social responsibility in engineers. *International Journal of Engineering Education*, *31*(1), 414–424.

[8] Sankar, P. L., & Cho, M. K. (2015). Engineering Values Into Genetic Engineering: A Proposed Analytic Framework for Scientific Social Responsibility. *American Journal of Bioethics*, *15*(12), 18–24. https://doi.org/10.1080/15265161.2015.1104169

[9] Eliasa, E. I. (2014). Increasing Values of Teamwork and Responsibility of the Students through Games: Integrating Education Character in Lectures. *Procedia - Social and Behavioral Sciences*, *123*, 196–203. https://doi.org/10.1016/j.sbspro.2014.01.1415

[10] Glerup, C., & Horst, M. (2014). Mapping 'social responsibility' in science. *Journal of Responsible Innovation*, *1*(1), 31–50. https://doi.org/10.1080/23299460.2014.882077

[11] Dima, A. M., Vasilache, S., Ghinea, V., & Agoston, S. (2012). A model of academic social responsibility. *Transylvanian Review of Administrative Sciences*, *38*, 23–43.

[12] Zandvoort, H., Børsen, T., Deneke, M., & Bird, S. J. (2013). Editors' Overview Perspectives on Teaching Social Responsibility to Students in Science and Engineering. *Science and Engineering Ethics*, *19*(4), 1413–1438. https://doi.org/10.1007/s11948-013-9495-7

[13] Caballero-Díaz, E., Simonet, B. M., & Valcárcel, M. (2013). The social responsibility of Nanoscience and Nanotechnology: An integral approach. *Journal of Nanoparticle Research*, *15*(4). https://doi.org/10.1007/s11051-013-1534-4

[14] Rusli, A. (2011). Science and scientific literacy vs science and scientific awareness through basic physics lectures: A study of wish and reality. *AIP Conference Proceedings*, *1454*(1), 169–173. https://doi.org/10.1063/1.4730713

[15] Zoller, U. (2011). Science and Technology Education in the STES Context in Primary Schools: What Should It Take? *Journal of Science Education and Technology*, *20*(5), 444–453. https://doi.org/10.1007/s10956-011-9306-3

[16] Krogsgaard-Larsen, P., Thostrup, P., & Besenbacher, F. (2011). Editorial: Scientific social responsibility: A call to arms. *Angewandte Chemie - International Edition*, *50*(46), 10738–10740. https://doi.org/10.1002/anie.201105641

[17] Walter, C., & Richards, E. P. (1998). The Social Responsibility of scientists: The scientific impact statement. *IEEE Engineering in Medicine and Biology Magazine*, *17*(6), 94–95. https://doi.org/10.1109/51.731328

[18] Marinescu, P., Toma, S., & Constantin, I. (2010). Social Responsibility At The Academic Level. Study Case: The University Of Bucharest. *Studies and Scientific Researches. Economics Edition*, *15*, 404–410. https://doi.org/10.29358/sceco.v0i15.147

[19] Holbrook, J. (2009). Meeting Challenges to Sustainable Development through Science and Technology Education. *Science Education International*, *20*(1/2), 44–59. http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=51924570&lang=es&site=ehost-live

[20] Rhodes, C., & Sulston, J. (2010). Scientific responsibility and development. *European Journal of Development Research*, *22*(1), 3–9. https://doi.org/10.1057/ejdr.2009.47

[21] Conlon, E. (2008). The new engineer: Between employability and social responsibility. *European Journal of Engineering Education*, *33*(2), 151–159. https://doi.org/10.1080/03043790801996371

[22] Bybee, R. W. (2008). Scientific literacy, environmental issues, and PISA 2006: The 2008 paul F-Brandwein lecture. *Journal of Science Education and Technology*, *17*(6), 566–585. https://doi.org/10.1007/s10956-008-9124-4

[23] Zandvoort, H. (2008). Preparing engineers for social responsibility. *European Journal of Engineering Education*, *33*(2), 133–140. https://doi.org/10.1080/03043790802024082

[24] Børsen Hansen, T. (2006). Academic and social responsibility of scientists. *ISYP Journal on Science and World Affairs*, *2*(2), 71–92.

[25] Beckwith, J., & Huang, F. (2005). Should we make a fuss? A case for social responsibility in science. *Nature Biotechnology*, *23*(12), 1479–1480. https://doi.org/10.1038/nbt1205-1479

[26] Weed, D. L., & Mckeown, R. E. (2003). Science and social responsibility in public health. *Environmental Health Perspectives*, *111*(14), 1804–1808. https://doi.org/10.1289/ehp.6198

[27] Weil, V. (2002). Making sense of scientists' responsibilities at the interface of science and society. Commentary on "Six Domains of Research Ethics". *Science and Engineering Ethics*, *8*(2), 223–227. https://doi.org/10.1007/s11948-002-0023-4

[28] Francis, C. K. (2001). The medical ethos and social responsibility in clinical medicine. *Journal of the National Medical Association*, *93*(5), 157–169.

[29] Fleischmann, M. (2000). Reflections on the sociology of science and social responsibility in science, in relationship to Cold Fusion. In *Accountability in Research* (Vol. 8, Issue 1). https://doi.org/10.1080/08989620008573964

[30] Pedretti, E. (1999). Decision Making and STS Education: Exploring Scientific Knowledge and Social Responsibility in Schools and Science Centers Through an Issues-Based Approach. *School Science and Mathematics*, *99*(4), 174–181. https://doi.org/10.1111/j.1949-8594.1999.tb17471.x

[31] Recher, H., & R. Ehrlich, P. (1999). The Essence of Science: The Social Responsibility of Communicating. *Pacific Conservation Biology*, *5*(3), 161. https://doi.org/10.1071/pc990161

[32] Ramsey, J. (1993). The science education reform movement: Implications for social responsibility. *Science Education*, *77*(2), 235–258. https://doi.org/10.1002/sce.3730770210

[33] Brunner, R. D., & Ascher, W. (1992). Science and social responsibility. *Policy Sciences*, *25*(3), 295–331. https://doi.org/10.1007/BF00138787

[34] Boeker, E. (1975). *Rip Egbert*. *5*, 457–484.

[35] J. A. S. (1915). American Association for the Advancement of Science. *Journal of Education*, *81*(3), 73–74. https://doi.org/10.1177/002205741508100313

[36] Youniss, J. and Yates, M.(1977), 'Community Service and Social Responsibility in Youth', available at Community Service and Social Responsibility in Youth - Professor Emeritus of Psychology James Youniss, James Youniss, Miranda Yates - Google Books (accessed 15 December 2020)

[37] Berman, S.(1977), 'Children's Social Consciousness and the Development of Social Responsibilty', available at Children's Social Consciousness and the Development of Social Responsibility - Sheldon Berman - Google Books (accessed 15 December 2020)

[38] Clifford, M.(1998), 'Environmental Crime: Enforcement, Policy, and Social Responsibility', available at Environmental Crime: Enforcement, Policy, and Social Responsibility - Mary Clifford - Google Books (accessed 15 December 2020)

[39] Frazer, M. J and Kornhauser, A (2014), 'Ethics and Social Responsibility in Science Education: Science and Education', available at Ethics and Social Responsibility in Science Education: Science and ... - Google Books (accessed 15 December 2020)

[40] Lewis, J. L. and Kelly, P. J.(2014), 'Science and Technology Education and Future Human Needs', available at Science and Technology Education and Future Human Needs - Google Books(accessed 15 December 2020)