

Advocating Output Criteria based Scientific and Research Methodologies: why the Reliability of Scientific and Research Methods Must be Measured based on Output Criteria and Attributes

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Abstract:- This is one of our several publications on research method and research methodology. In this paper, we support the idea of a structured and formal approach to scientific research. However, there may be many different exceptions to this as all types of research problems may not lend themselves to research in the form of pre-determined steps. Thus, the first preference would be to follow a standard and a highly structured and formalized scientific method wherever this is possible. In case this is not possible, the second preference would be to follow a self or scholar defined scientific method, but the latter is usually equally rigorous as well, with pre-defined and pre-determined steps. The third and last preference: is to follow a free-form approach where the steps are not pre-defined to a high degree. In such as case, the researcher refines the method as the research evolves and progresses and the time goes by. However, we can only support a structured and a graduated approach to free-form method, and the reliability of output must also be always borne in mind. As such, this is expected to be a vastly superior approach to a completely free-form method, and could lead to a vastly superior research output. The method followed must preferably be documented, but this may not always be possible or necessary. At the very least, the essential characteristics of good science such as objectivity, reliability, accuracy, comprehensiveness, rigour, and precision besides may others must be adhered to. We are aware that the quality of research output in developing countries is low. Therefore, this paper also keeps in mind our philosophy of the globalization of science, and the enhanced quality and quantity of scientific output in all contexts and situations.

I. INTRODUCTION

“Dispassionate objectivity is itself a passion, for the real and for the truth.” Abraham Maslow

This is one of our several publications on research method and research methodology over the last one year or so, though the foundation of much of our work has been laid over the past two decades. In this paper, we support the idea of a highly structured and formal approach to scientific research, as far as this is possible or attainable. However, there may be many different exceptions to this as all types of

real-world and practical research problems may not lend themselves to research in the form of a set of pre-determined steps. Thus, the first preference would be to follow a standard and a highly structured and formalized scientific method wherever this is possible. In case this is not possible, the second preference would be to follow a self or scholar defined scientific method, but the latter we believe, must be usually equally rigorous as well, with both pre-defined and pre-determined steps. The third and last preference: is to follow a free-form approach where the steps are not pre-defined to a high degree. In such as case, the researcher either refines and formulates the method as the research evolves and progresses and the time goes by, or follows his gut feel or instinct on most matters.

However, we can only support a structured and a graduated approach to free-form method, and the reliability of research output must also be always borne in mind along with reproducibility of results. As such, this is expected to be a vastly superior approach to a completely free-form method, and could logically and naturally lead us to a vastly superior research output as well. This would essentially be a via media approach, and would sit in between the approaches proposed by traditionalists, and the free-for-all-approach proposed by radicalists such as Karl Popper, and is such designed to provide a consistent high-quality output. The method followed must preferably be rigorously and thoroughly documented, but this may not always be possible or necessary. At the very least, the essential characteristics of good science such as objectivity, reliability, accuracy, comprehensiveness, rigour, reproducibility, consistency, and precision besides may others must be adhered to. Many of these are derived from our core principles of Twenty-first century historiography while others are extensions of the characteristics of good scientific research. We are aware that the quality of research output in developing countries is presently quite low, and a handful of nations dominate scientific research in most fields.

Therefore, this paper also keeps in mind our philosophy of the globalization of science, and the enhanced quality and quantity of scientific output in all contexts and situations. This approach would serve the interests of all peoples and denizens from across the world regardless of their nationality and cultural orientation. It would particularly help people of the Global South (This term was

invented by Carl Oglesby and others) who have thus far lagged behind in science and scientific research. This would naturally lead us to a better quality of scientific output on the whole, and lead us to intellectual pyrrhonism too by reconciling diverse sets of ideas and castigating all forms of dogma. It would also lead to what we had called “Scientific progress at the speed of light”. For example, there is scanty any scientific tradition worth its salt in modern contemporary India, and in many other developing nations too. All this needs to change in due course, and this can have a major multiplier effect on scientific activity as a whole. We also need more horizontal and vertical collaboration in science, ahem!

We had also spoken about Horizontal collaboration and Vertical collaboration in our earlier paper. Both are extremely important in their own ways. We also request that developed countries reach out to developing countries collaboratively, and in a true spirit of mutual amity and self-respect. We need to mark the end of the era of western-centric and western dominated research and mark the beginning of a more globalized and a collaborative era of research. At the same time, we must also mark the transition from an ideology-driven research era (including religious ideology driven scholarship) to an ideology-free research era. On both counts, we need to declare boldly and unequivocally that the transition is complete when it really is. There is no room or scope for the old ways to continue. Thus, the old Witzel, Asko Parpola and Gregory Possehl era in Indology, Indus studies and Ancient India studies must also concomitantly come to a rapid end. Indian Marxist historians are likewise, relics of a bygone age, and do not really partake in twenty-first century values. This is just a stray example. Parallel examples can be culled from various other related fields of study, and completely different disciplines too. At the same time, we look forward to changing individual mind-orientations among citizens in countries like India, and collective or societal mind-orientation to tally with a more scientific temperament and aptitude. It should also be characterized by a smaller pre-occupation and obsession with religion. There is virtually no knowledge of scientific method in India even among the highly educated and the elite. All this must change within a generation, and if this happens, will be a major triumph for science in general. We had discussed this in our two papers dealing with socio-cultural change.

The entire approach proposed in this paper is also highly recommendatory in nature. This approach it is expected, could distinguish high quality research in the real world from less than high quality research as well. More than a completely free-form approach, this approach is expected to lead to a more controlled, repeatable and a verifiable process. We do not therefore essentially recommend an entirely free-form approach, but an approach with multiple checks and balances. We also do not recommend any no holds barred approaches, or highly subjective postmodernist research philosophies either. This approach will not be useful just in historiography, not even just in various fields of social sciences, but in virtually any field of scientific activity and endeavour under the sun. For

example, we have used such approaches in our research publications on the Aryan problem, the identity of the Harappans and the origin of Brahmi all of which were conceptualized, formulated and written between the years 2005 and 2013. In these papers, we did not specify the research method used in a separate section of the research, but made it amply and abundantly clear to anyone who would read it carefully. Thus, a controlled approach to research was followed in these papers, and well communicated to audiences. In addition to all this, there is one thing we have emphasized all along. Every researcher must possess an “objectivity in mindset”. This will naturally be an essential pre-requisite for progress, and we have been emphasizing this all along. This cannot naturally be represented by means of an event, not even a seismic one, but by a paradigm shift spanning several decades. The Indian Hindutva pre-scientific far right has a penchant for coming up with weird, untenable theories that do not cut the ice, examples of these being the Out of India theory, and theories based on “Archaeoastronomy” (which is already dubious, but is used by them in a much more twisted and a warped sense) among other things.¹

Not only do many pseudo-scientists follow their own dubious methods, but their methods are not qualitatively tied to output. Such tendencies must be nipped in the bud, and relegated to the background. This is because the proof of the pudding lies in the eating. The far left also does not often adhere to objectivity, and we primarily look forward to an ideology-free approach to scientific research in the days and years to come. The left has also destroyed itself in the years the Author since has commenced his work, and has more or less vanished into oblivion; this has simplified things a little bit, but the far right (which has considerably weakened remained a potent force) This effort is also in keeping with our idea to develop and to formulate down to earth and real-world based approaches rather than highly philosophical and unworkable or unimplementable abstractions. Thus, simple, workable, practical and pragmatic approaches, it is expected, will highly boost the quantum of high quality research in all parts of the world. It will also give research from developing countries and other parts of the world more teeth. Everything must be tied to the quantum and quality of scientific output, in fact everything. Science, particularly the social sciences must serve society or societies in such a way that such a society or societies can produce better and more reliable science, and a greater scientific output. Thus, this approach is in humble service to more and better science, and better scientific and human progress without unwanted digressions and deviations. All other attributes of good research must also of course be followed such as referencing, citations, and attributions, and our work and approach stands neutral to such generic principles. The ideas and ideals of this paper were not born from the Author’s fecund imagination alone; they are a product of nearly two

¹ Howell, Kerry E. *An Introduction to the Philosophy of Methodology*. SAGE

decades of research in solving complex and intractable problems.^{2 3 4 5}

➤ *Characteristics of this Approach*

The following are therefore, the essential characteristics of this approach.

- Wherever possible, a highly structured, rigid, a predefined and a standard research methodology must be followed, with steps in the research methodology clearly delineated and rigorously and assiduously so. There are standard steps in the scientific method that are available from most scientific literature, and these are followed for most part of the time.
- Wherever the above is not possible, the scholar or research may develop his own structured and pre-defined approach to research and research methodology with a similar level of rigour, exactitude and precision. This would often and typically comprise of the steps in the standard scientific method but would include some variations. Some steps could be skipped or some amplified, i.e. pursued at a greater level of detail. Thus, a researcher may synthesize or reconcile contradictory primary or secondary data as a part of this research method or strategy. Thus, we had advocated the adoption of generic principles over static methods in our paper on the core principles of twenty-first century historiography, and had recommended even that scholar defined methods be used. This philosophy can be extended to all fields of scientific activity but of course comes with a caveat; wherever possible, a standard scientific methodology can be used. There would also of course be variations based on the field of scientific inquiry; for the field of historiography, the standard sequence of steps in the scientific method could be used less often.
- Wherever either of the two is not possible, the researcher may follow his own flexible method, based on his own considerations or exigencies, and this may evolve or change as the research progresses. It must also be mentioned at the very outset, that the methodology employed must be robust enough notwithstanding the output characteristics it may yield. The research methodology employed. It must also not be blatantly

wrong or weak from the start. Can the substratum method employed to identify the languages of the Indus valley civilization be considered foolproof? Almost certainly not. Neither will approaches followed by most Indian Marxist historians ever be. Asko Parpola's research methods are certainly not robust either. However, methods and techniques employed by researchers must be critiqued by other researchers thoroughly; this must be done purely and solely in the interests of science; there must be no personal vendetta or any other hidden agenda.

- The key philosophy here is that the quantum or quality of research output must not be compromised, and the presence or absence of a pre-defined research methodology must be geared towards this singular objective i.e. the singular objective of promoting more and better research.
- The approach to be followed for the research or the investigation being carried out must preferably be documented thoroughly. This may not however always be possible, and the quality of the research in that case, must be evaluated against the research output criteria.
- An approach note must also be prepared if possible detailing all aspects of the research methodology, the possible key points and limitations.
- If the approach changes, the changed approach must also be documented, and the details of changes must also be highlighted.
- It must be stated upfront why a standard research methodology cannot be followed. A detailed justification must be provided, along with the potential problems that may ensue if a standard model is followed.
- List of output criteria must be defined. The standard list of criteria encompassing good research criteria must be used, and any omissions must be justified. Examples of these criteria as reliability, accuracy, precision, rigour, comprehensiveness etc. These have been discussed in detail as a part of this paper.
- It must be explained how output criteria are proposed to be met or satisfied through the research methodology being used.
- Attributes and values may also be defined and provided if possible, for the research criteria, and these could also be extended to cover pass or fail criteria.
- The complete traceability matrix to output criteria must be provided. It must be shown how output criteria are proposed to be accomplished.
- If certain output criteria cannot be accomplished, a proper, and a thorough justification must be provided.
- The approach must also state how exceptions will be documented and handled (Refer our paper on the "Sociological Ninety-ten rule" which was published by us earlier in 2023)
- The approach must also state if possible how uncertainties and grey areas will be handled (Refer our paper on the "Certainty Uncertainty principle" which was also published by us earlier in 2023)
- Any cross cultural issues must also be tackled and handled, and must form a part of the research design.

² Unveiling the Sociological Ninety-ten rules for Social Sciences research: Towards better hypothesis formulation in the Social Sciences in the interests of higher quality research and intellectual multi-polarity Sujay Rao Mandavilli Published in IJISRT, February 2023

³ Elucidating the Certainty uncertainty principle for the Social Sciences: Guidelines for hypothesis formulation in the Social Sciences for enhanced objectivity and intellectual multi-polarity Sujay Rao Mandavilli IJISRT, March 2023

⁴ Operationalizing cross-cultural research design: Practical, cost-effective, and a minimalistic application of cross-cultural research design to minimize cultural bias in research and reconcile diverse viewpoints IJISRT, April 2023 Sujay Rao Mandavilli

⁵ Grover, Vijey (2015). "RESEARCH APPROACH: AN OVERVIEW". *Golden Research Thoughts*

- We also recommend inductive approaches over deductive approaches, grounded theory and nomothetic approaches to rule building. We had discussed these in a paper on inductive approaches earlier in 2023.
- Relevant aspects of the above may be carried forward to the peer-reviewed journal submission, and relevant aspects documented in the main paper itself. If this cannot be suitably accomplished, (too much information may clutter up the main paper) the researcher should retain his own traceability. An informal or formal traceability matrix should therefore be an essential part of a sound research exercise.
- This kind of approach and documentation will ensure that other researchers can use the techniques and output of the research in question in their own downstream research if need be, much more reliably and consistently, and it will also be much more easily understandable to the general public.
- This approach is only recommendatory. All the steps above need not be formally documented as a part of the research paper or research output, but we suggest that it be followed in letter and in spirit, and built into the research method and methodology nonetheless.
- The core tenets of this approach must be reflected in the research output. This would be the acid test of this approach.

II. OVERVIEW OF RESEARCH METHODS

The concept and the idea of research refers to, and encompasses the systematic gathering of data and information and its analysis for advancement of knowledge in any subject. Research attempts to find answers to intellectual and practical questions regarding unknown and uninvestigated phenomena through application of systematic methods. It also leads to the uncovering of hidden truths regarding various natural and manmade phenomena. It is thus an exciting voyage of discovery which leads to the advancement of human knowledge by understanding different phenomena more thoroughly. Research must also be carried out in the service of society, though there is still a gap between the two; we have always believed that this gap can be bridged through a more globalized and a hands on approach to science. The English word research originates from the French word *rechercher*, and is comprised of two parts, namely “re” and “search”. The term has been traced all the way back to the year 1577. (Thyer, 2001) According to a definition provided by the Webster’s Collegiate Dictionary, research is “a methodological and a studious inquiry or examination; (especially an investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws”. Many other definitions of research have been provided by different thinkers and intellectuals, and it is pointless and unnecessary to repeat them ad nauseum; readers may simply refer to our earlier published research papers on the scientific method and philosophy of science, of which there are indeed many, to get those definitions. We had discussed the essential characteristics of social science

research as well, but the concepts and postulates of this paper would apply to any form of research.⁶

Scientific method may be defined as a process of establishing facts systematically and objectively through a continuous process of testing and experimentation. There are many different steps involved in the scientific process, but the most basic steps and the steps common to all processes involve defining the research question or problem, making a series of systematic observations, reviewing both primary and secondary literature, formulating hypotheses (which may be derived from older hunches and conjectures), making predictions about dependant and independent variables and establishing relationships between the two, conducting experiments as a part of the research process and finally validating the results. Good research also applies rigorous skepticism, and minimizes the number of assumptions used. Good research also has universal applicability, and lays bare the exceptions wherever necessary. It also does not follow any ideology. Good research is also often interdisciplinary and multicultural. Thus, the outcomes of scientific activity must also be credible, dependable, reliable, repeatable, verifiable, coherent, comprehensive, reproducible, transferable to other contexts, and self-correcting, and these attributes would set good research apart from bad ones. The hypothesis which is initially formulated may be modified, or additional tests conducted wherever necessary.

Scientific method has existed since ancient times, and was employed by the Ancient Greeks as well in the ideas of philosopher Leucippus and his pupil Democritus who developed the idea of atomism. We also had Thales and the pre-Socratic school. Aristotle also made contributions to scientific method through the publication of *Organon* and *Metaphysics*. The British historian De Lacy O’Leary even goes as far as to call him the father of modern science. The Greek philosopher Epicurus is also said to have contributed to scientific method. Some contributions to scientific method were also made by the Ancient Egyptians (as evidenced from the ancient medical text *Edwin Smith papyrus*) and the Ancient Indians. The Arabs also made contributions to scientific method during the Islamic Golden Age. It has however come of age only in the seventeenth century, during the scientific and intellectual revolutions of the Post Dark Ages Europe. Thus, while Ancient India did make some contributions to science, modern say Indians must stop winnowing the past for glory, and focus on contemporary excellence.

Research is also broadly categorized into quantitative and qualitative research. In case of the former, mathematical or statistical tools and techniques are widely used, while in the case of the latter, such tools are not generally employed. Certain kinds of research employ both quantitative and qualitative research techniques, and this approach is referred to as mixed methods research. Research is also sometimes

⁶ Research Methodology: Methods and techniques, Second Revised Edition, CR Kothari, New Age India Publishers, 1990

classified into pure and applied research. In case of the former, the end use of the research is not known, and research is only carried out to acquire knowledge. In case of the latter, research is carried out to solve real-world and practical problems. There are other forms of research such as experimental research, quasi-experimental research, descriptive research, analytical research, co-relational research or causal research, exploratory research, explanatory research, cross-sectional research and longitudinal research. It is also often classified into structured research and unstructured research. We have discussed all these terms and concepts in our previous papers.^{7 8}

Good qualitative research comprising interviews which may be either structured and unstructured, questionnaires, focused group discussion or FGD, fieldwork, ethnography and the participant observation method (including what we called econoethnography), can be highly effective too in social sciences research, if their principles are followed in letter and spirit. On the other hand, quantitative research techniques are highly useful in many other fields of sciences such as Physical Anthropology and the Biological sciences. In such cases, qualitative research techniques may not work or do the job effectively.

Modern scientific thinkers have included Karl Popper. According to Popper, scientific theory should make predictions that can then be tested, proven or falsified, and the theory should be rejected if these predictions are shown or demonstrated not to be correct. According to Popper, science would best progress using deductive reasoning as its primary focus and emphasis, and this would be known as critical rationalism. According to the doctrine of critical rationalism which has its supporters and critics, if a statement cannot be logically deduced from what is known, it might nonetheless be possible to logically falsify it. According to Karl Popper's falsifiability principle, and research must be falsifiable, and this would be a characteristic of a good research. Thus, any theory can be falsified with just one counter-observation, and new theories that consider additional contrary data be proposed. According to Popper, this is how science progresses. We do not however concur with Popper's refutation of inductive approaches and ampliative reasoning. We also support the idea that inductive reasoning be used as far as possible, and this could lead us to genuinely better science. We also look forward to the democratization of knowledge, and the castigation of superfluous or redundant bombastic terminologies, verbosity and jargon. This should also be one of the pillars and characteristics of twenty-first century science. This was pre-empted in the twenty-first century due to careerism and western-centric approaches.

⁷ Research Methodology: Tools and techniques Dr. Prabhat Pandey Dr. Meenu Mishra Pandey © Bridge Center, 2015

⁸ Research Methodology, Second Edition, R. Panneerselvam, Prentice Hall India, Eastern economy edition, 2014

These approaches must all now be jettisoned in the twenty-first century, and more democratic and people-centric scientific approaches followed across the world. Researchers and scientists particularly physicists and some others, have looked down at people from a pedestal and a high horse, and have never attempted to spread scientific knowledge among the masses, exceptions like Sir Arthur Eddington notwithstanding. There are some institutions aiming to popularize science among the common man, but this field has failed to reach its full potential. Thus, the democratization of science and the wider dissemination of ideas and techniques is also an essential pillar of the globalization of science. The two go hand in hand. The democratization of science can also lead to a social sciences revolution of sorts (This is the crying need of the hour and day because social sciences research has hitherto unfortunately lagged behind other fields of research, and we have all along endeavoured to set right this anomaly) and intellectual and scientific revolutions as well where such revolutions are due, and where pre-scientific constructs still reign supreme.^{9 10}

III. KEY CHARACTERISTICS OF GOOD RESEARCH

Thus, the key characteristics of good research would be as follows, and any scientific method that is followed, should always keep these principles at heart. Any research that does not satisfy these principles must be deemed to be inadequate. Any scientific method that achieves, attains or accomplishes these characteristics and objectives would contrarily be said to be in order. Thus, this approach would lend itself to critical scrutiny and crystal-clear transparency. It is also simple and easy to understand and can be followed by most scientists regardless of discipline or cultural affiliation. Even in case of fields such as historiography where there may be no mainstream research methodologies or techniques employed, research processes can be vetted or ratified against pre-specified output characteristics. Some characteristics could be highlighted in a given type of research, and everything would depend on the objectives of the research, and the core values and the philosophies of the researcher which we expect would be global-oriented, and humanity-focused. The adoption of high quality research methods by researchers, and the communication thereof to other researchers could reduce the latency time for the acceptance of new research which at present remains unnaturally and unacceptably high. This is also often coupled by researchers' penchant for ideologies, and it is often decades before new research is widely accepted. Thus, a controlled process to science is always necessary. We do not mean this to be a wet blanket, but an uncontrolled process is far too dangerous and irresponsible. It does not also do justice to other researchers in the field. Thus, if one wishes to state that the Rig Veda contains a certain form of knowledge, it must be established reliably and incontrovertibly. Whatever is correct must indeed be

⁹ The open society and its enemies by Karl Popper, Princeton and Oxford, Princeton University Press, 1945

¹⁰ The logic of scientific discovery, Karl Popper, 1959

accepted, but follow a reliable method. must also be grounds up wherever required, and where there is too much clutter or ideological baggage. This would also be one of the requirements of good research, but only in some case.^{11 12 13}

➤ *Objectivity*

Objectivity in scientific research occurs or is said to take place when there are no personal biases or personal opinions involved in the process of research. Scientists must always strive to reduce bias and subjectivity in their output, which may arise when personal judgments and beliefs override objective considerations. This is however, by no means always easy. The underlying assumption of objectivity is the idea that truth exists independently of an observation or investigation, and that the researcher should not contaminate the truth. Also note that objectivity is indeed always necessary to formulate an accurate explanation of how things work in the world, and further downstream researcher would greatly benefit from it. However, poor quality research would have an aggregate net negative downstream effect, and we had introduced a concept called QEPIS (Quantification of the effects of poor or Ideologically-driven scholarship) in our paper on Twenty-first century historiography.

Objectivity must be aggressively pursued not only in quantitative research, but in qualitative research also. Some groups of individuals particularly post-modernists have harped ad nauseum on the subjectivity of interpretation. We cannot concur with this except in extreme circumstances, such as where new and meaningful hypotheses are being formulated. There is also a world of difference between objectivity and objective-driven approaches. The latter refers to a fulfillment of the research objectives of the study at hand, and must be accomplished nonetheless. This alone would not however indicate that the research is objective. The idea of objectivity is also linked to the idea of positivism which states that only information gathered from real-world observations and real-world data is reliable. Objectivity is must also eliminate all forms of cognitive biases such as confirmation biases. Confirmation bias, as proposed by the English psychologist Peter Wilson, refers to selective processing of data; people mentally process and accept data which confirms to their belief systems, and reject almost everything else.

➤ *Reliability*

The idea of reliability means that the research output is capable of being used by downstream researchers without any further investigation or modification. Thus, the research

must not have a myopic outlook and must be able to envisage the downstream implications of his research. This good research has an ampliative quality to it, and begets further good downstream research. Research reliability refers to the idea whether research methods can reproduce the same results when experiments are carried out repeatedly or multiple times. If research methods can produce consistent results whenever the experiment is repeated, then the methods are likely to be reliable and not influenced by any extraneous factors. Reliability on the other hand, is the idea that scientific output is reliable only if it is produced by a reliable process.

➤ *Validity*

The idea of validity refers to how well a scientific test or research activity actually measures what it seeks to measure, or how well it reflects reality and real-world considerations. Validity may also be categorized into internal validity and external validity. Internal validity refers to the extent to which evidence is valid within the context of a particular study. External validity on the other hand, refers to the extent to which a claim is valid against external data or observations. It also refers to whether the results of a study can be vetted or ratified against external ideas or concepts. We may also refer to the theory of paradoxes here; any theory, hypothesis or paradigm is effectively useless if it contains a large number of internal and external paradoxes.

➤ *Precision*

The concept of precision refers to how close measurements of the same item are to one other. The idea of precision is independent of the ideal of accuracy. This is because accuracy refers to how close observations are to the widely accepted value. Therefore, it is possible to be extremely precise without being very accurate, and vice versa. Both precision and accuracy are required for science to be accepted as high-quality science.

➤ *Accuracy*

Accuracy refers to how well an observed value tallies with a more widely accepted value. It may also sometimes refer to the match between the sample population and target population. Accuracy must thus be differentiated and distinguished from precision, and both these are absolutely required for research to qualify as high-quality research. Both accuracy and precision must be constantly measured and verified by a researcher as a part of his study, and red flags raised whenever these are compromised. In addition to precision and accuracy, data validity and reliability are also necessary for research to be categorized as high-quality research.

➤ *Rigour*

Rigour refers to the quality of being extremely thorough and careful. It also at times refers to the principle and characteristics of following rules, regulations, processes and procedures in an extremely thorough way, and communicating them effectively as well. Rigorous research is also often accompanied by a thorough analysis and handling of data or exceptions. Rigour does not always necessarily mean precision and accuracy, and rigour does

¹¹ Enunciating the Core principles of Twenty-first Century Historiography: Some additional extrapolations and inferences from our studies and observations on Historiography Sujay Rao Mandavilli ELK Asia Pacific Journal of Social Science (ISSN: 2394-9392) in Volume 2, Issue 4 July to September 201

¹² Introduction to research methods: A hands on approach, Bora Pajo, Sage Publications, 2017

¹³ The practice of qualitative research, SNH Biber, 2013, Sage Publications

not necessarily guarantee us objectivity. However, rigour is an important cog in the wheel and takes us closer to the truth. For example, the Indian Marxist historian DN Jha was rigorous, but arguably not objective as he was driven and motivated by ideology. These people can be given away by their cherry-picking of data or one-sided and limited interpretation of data. The same holds good of Hindutva proponents who often subscribe to victimhood narrative, and cry out foul over alleged unfair play and discrimination.

➤ *Systematicity*

Systematicity from the standpoint of research output refers to the idea that the output has been arrived at systematically and methodologically, and that all non-correct alternatives and hypothesis have been systematically eliminated from the result. This approach will guarantee us that the research output is fair, objective, credible and reliable. A classic and an ideal example of a systematic scientific study is a experimental study where there is a blind assignment of subjects to control and experimental groups. This approach will however, not necessarily guarantee us success by itself, and other attributes and characteristics of a good research need to be followed.

➤ *Verifiability*

Verifiability means that the result must be capable of being verified. A phenomenon is said to be scientifically verifiable if it can be tested and proven to be true, or alternatively falsified. Verifiability also implies measurability, and it means that the phenomena is capable of being observed and measured. At the same time, the research must be transparent, and other researchers must be aware as to how a conclusion has been reached; thus, the entire traceability of research methods and methodologies must be established. This is necessary because the researchers study will be used by several other researchers in the field and in other fields for the downstream research. Thus, DN Jha's research must not be supported or idealized because it is highly one sided and biased and misleads other researchers as well. We would look forward to a thorough and a meticulous critique of DN Jha's works (which do not certainly constitute good and healthy science) by other scholars in the days and years to come.

➤ *Measurability*

Measurability means the research output must be capable of being measured by means of suitably designed metrics and measurements. This may not however be always be possible or necessarily, and may not be possible in case of qualitative research. A range of mathematical models and statistical tools and techniques may be used to measure research output, and other quantification techniques such as time and spatial measurements are also sometimes used. Sometimes, other techniques such as the computation of threshold values and Likert's scale can also be used.

➤ *Falsifiability*

Falsifiability is the capacity or the ability of some proposition, theory, statement, or hypothesis to be falsified or proven incorrect or wrong. According to Karl Popper, falsifiability is an important characteristic of a good

research, and in this connection, the famous white swan and black swan analogy was used. Falsifiability also makes a theory predictable, testable and eminently usable. The notion and idea of falsifiability is also related to the problem of demarcation which discussed the demarcation between science and pseudo-science. The Certainty uncertainty principle on the other hand, would imply looking for uncertainties in a hypothesis and seeking to eliminate them. It would also imply ranking evidence for and against a hypothesis on the basis of their certainty and uncertainty.

➤ *Repeatability*

Repeatability refers to the measure of the ability of a given research or scientific method to generate either the same or closely similar whenever a test is designed to be repeated and re-executed a multiple number of times. This is however subject to certain factors and considerations; for example, the experiment must be controlled, and all the other factors involved must be exactly identical. This characteristic is of particular importance to quantitative research; however, repeatability and reproducibility is less likely in case of qualitative research, and most fields of social science research.

➤ *Reproducibility*

Reproducibility from our perspective, is somewhat different from repeatability. Though similar, reproducibility refers to how the results of an experiment can be reproduced in other contexts and situations. Reproducibility allows for more accurate and widely usable research, whereas repeatability measures the accuracy of research and confirms the accuracy of the results. Reproducibility is also similar to the idea of replicability, Replicability is replicating the study under different circumstances, and is usually done by a different researcher or by the same researcher. Research must also usually have universal applicability unless explicitly stated.

➤ *Credibility*

Credibility is an English term which means the quality and attribute of being trusted and believed in. It is also synonymous with trustworthiness. Credibility in research may refer to many different things; it may refer to the credibility of the researcher himself, or it may refer to the credibility of the research method employed. It may also at times refer to the credibility of the research output as well. The idea of credibility may be either subjective or objective, and may be used for both qualitative and quantitative research. The term credibility may also often refer to sources of data used in the research. Different researchers are associated with different levels of credibility, and researchers must attempt to build up credibility slowly, and over a period in time.

➤ *Coherence*

The term coherent with respect to an argument, theory, premise, or philosophy means that it is logical, lucid, reasonable, well-argued, well-reasoned, well-rounded and internally and externally consistent, cogent and sound. In other words, it is also sound in a holistic sense, and formed a consistent and a unified whole. A coherent paper is

comprehensive, and possesses the traits, attributes and characteristics of logical consistency. It traces all aspects of the research consistently from the cradle to the grave, and embraces all important internal and external touch points for a complete and a comprehensive research.

➤ *Comprehensiveness*

The term comprehensive as an English word means to include or deal with all or nearly all elements or aspects of a particular issue or problem. For research to be comprehensive, it must cover the issue or the topic at hand completely or almost completely, by accounting for or encompassing all or nearly all important and relevant considerations. No stone must be left unturned to make the study as comprehensive or as all-encompassing as possible, and no significant aspects must be left out from the study. Thus, the research output must be multi-dimensional, and must take into account all relevant facts from all relevant fields of science. It must also satisfy the principle of exceptionism, and take into consideration all kinds of exceptions, even cultural ones. Refer to our paper on the Sociological ninety ten rule.

➤ *Holism*

Holism refers to the theory and idea that parts of a whole are interconnected with each other, such that they cannot exist independently of the whole, or cannot be completely understood without reference to the entire whole, which is always greater than the sum of its parts. Methodological holism in science and research is an approach to research that emphasizes the interdependencies of parts in the study of complex systems, and that approaches to science must be methodologically holistic. This approach would naturally lead us to a holistic research output. Another related concept is that of confirmation holism. In the philosophy of science, confirmation holism, also known sometimes as epistemological holism, refers to the idea that no individual statement can be confirmed or refuted by an empirical test, but only by a set of congruent statements constituting an entire theory. Thus, a healthy scientific temper is lacking sorely in India, and probably other developing countries as well, as people there often make appeals to authority, and resort to other pseudo-scientific practices as well.

➤ *Coherentism*

The doctrine of coherentism states that for a belief to be justified it must belong to a coherent system of beliefs, and the beliefs that make up that system must cohere with one another. We also have the coherence theories of truth which characterize truth as a property of whole systems of propositions where individual propositions must confirm to the whole. Thus, if any Indian scholar or researcher makes a statement about a real or imagined Indian epic age, it must also satisfy the principle of coherentism, and draw data or information from all relevant fields or study. Thus, the principle of coherentism must also be satisfied with respect to research output, and this would distinguish good quality science from poor quality science.

➤ *Transparency*

In normal English parlance, the quality of transparency is the quality of being easily seen through. Research must also necessarily be made transparent, and all assumptions of the research, the data employed, and the tools and techniques used must also be made transparent such that other researchers can trace the research easily. However, this is seldom adhered to in practice due to careerism (i.e. the desire to protect their careers and dissuade rivals from entering the field) and other factors.

➤ *Abstraction*

The process of abstraction involves the induction of ideas and the synthesis of particular facts into a general complete or comprehensive theory about a particular issue, along with the formulation of rules and laws. Smaller, less important concepts are then interconnected into a much larger and an interconnected whole. Abstraction is the exact and diametric opposite of the concept of specification, which refers to the analysis or breaking-down of a general idea or abstraction into concrete facts.

➤ *Predictability*

In science, predictability refers to the degree to which a prediction regarding an event or an occurrence can be reliably made, either in qualitative or in quantitative terms. Good science must also encompass reliable and predictable processes, and makes it clearly known what is to be expected. Scientists must also make reliable predictions about future events on the basis of the research conducted. In some cases, scenarios can be formulated; for example, researcher may come up with various climate change scenarios, and population growth scenarios since the outcomes in these two cases are less than certain.

➤ *Consistency*

Research must also be internally and externally consistent. In case of internal consistency, all aspects of the research including data, are internally consistent with one another, while in the case of external validity, the research is consistent with external data or phenomena. Consistency is sometimes qualitatively and statistically expressed in terms of co-relation metrics. Theories must also be internally and externally consistent, and must not only cover all observable data, but must also be logically consistent.

➤ *Empiricism*

We then also have the concept of empiricism which states that true knowledge and justification comes primarily from sensory experience. As such, this represents an epistemological view or position. The idea of empiricism competes with the doctrines and philosophies of skepticism and rationalism from an epistemological standpoint. Thus, research output must also justify the principle of empiricism. We then also have the doctrine of methodological naturalism which states that all explanations to phenomena must lie within the realm of natural causes.

➤ *Ethics-based Research Output*

A good research is carried out by following research ethics, and all times and this commitment to research must translate to research output as well. An ethical research work safeguards the virtues of truth, honesty, impartiality, accountability and integrity at all times. Good research also protects the rights and dignity of the study subjects, and does not violate or transgress their data rights. A good research also ensures that researchers uphold principles like impartiality, honesty, integrity, and accountability in their work.

➤ *Non-Dogma and Openness to Research Results*

There must be non-dogma and openness to research results (and various outcomes) at all times, and the researcher must not influence the research results in any way. This is a golden principle to be followed at all times, and in practically any kinds of research. Thus, however hard it may be, researchers must not harbour pre-conceived notions of any kind, or any cultural bias as well. These can be eliminated by means of techniques such as dialectical approaches.

➤ *Provisionality*

Research output must be deemed to be provisional at all times, and no researcher can stake claim to the absolute truth. Thus, the research results must be capable of being revised as and when more data is collected and analyzed, or as an when assumptions become untenable. This would be an essential characteristic of a high-quality research. We had also proposed the idea of qualified historiography in a paper published in 2022. As per the tenets of this paper, historical narratives could be qualified as being provisional, and then worked upon later as more evidence is collected or found.

➤ *Output Derived from Controlled Process*

A controlled process and a sound research methodology must be adopted and followed at all times. Thus, the overall quality and success of a research study is by and large determined by the research methodology that it uses (Thattamparambil 2020). It is the prerogative of the researcher to choose the research methodology that he wants. However, it must make sense in the context of the research problem and nature of study, and must be reliable and economical to operate. From our perspective, it must also lead to all the research characteristics presented in this paper, and lead to valid and reliable results. (Jansen & Warren, 2020)

➤ *Non-Excludability*

We must also follow what we may call the principle of non-excludability. Thus, according to this principle, one characteristic of a good research output cannot exclude others from being followed. Thus, in other words, all the characteristics of a good research output must be adhered to at all times, and in tandem. Any scenario where only a few characteristics of a high quality research are realized, and some others ignored, won't pass muster.

➤ *Universal Applicability*

Let us save the best for last. Last but not the least, research output must have universal applicability, and this principle lies at the heart of our philosophy of the globalization of science. Exceptions may of course arise, and these must be properly documented in the context of the situations in which they have arisen. Readers may refer to our paper on the Sociological Ninety ten rule to understand the principle of exceptionism.

IV. CONCLUSION

This paper has been one of our several publications on research method and research methodology. In this paper, we supported the idea of a structured and formal approach to scientific research. However, we argued that there could be several different kinds of exceptions to this rule as all types of research problems may not lend themselves to research in the form of pre-determined steps. Even though the research may modify the research methodology in such cases or utilize a more free-form approach, it must be borne in mind that the proof of the pudding is in the eating. Thus, the quality of the research output must be borne in mind at all times, and will be the anchor on the basis of which all research will be judged. Anything less than this would simply be unacceptable. We fervently hope that this kind of an output-driven analysis of research would lead to a higher quantum and quality of research output in different parts of the world, and serve the needs to society much better as well.