



Beginning Research: A First-Principle Guide for Even the Computer Science Researcher

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Abstract: Understanding the requirements and demands of research has often always been a challenge for the beginning researcher. Undergraduate and early postgraduate students alike get very easily frustrated in this regard. Rightly so because the pressure to adhere to the global ethics, techniques and methods, requirements, specifications, as well as other demands that are placed on research could easily get overwhelming especially for the research beginner. It very often feels like being required to put so much together and into right perspective, all at the same time and into one piece. Understanding these in general perspective is one challenge; the other being the need to tailor these generic and seeming complex demands to fit into another complex field such as Computer Science with numerous associated specializations. This paper presents an overview of the most fundamentally global demands of research in a very simplified manner, and how it can be tailored to find footing in areas of Computer Science Research; all put together from a traverse of existing literature, as well as a depth of experience in research and academics. The beginning researcher would find this a very compact “*first-principles guide*” to research; especially in Computer Science from which field most illustrations used in this research stem.

Keywords: Research, Research Methodology, Computer Science, Computer Science Research, Academia.

I. BACKGROUND & INTRODUCTION

Research as an activity is one that is as old as humanity itself. Even though it did not always have the structure, format and specifications it now has, it is an activity that had always been engaged in and woven, albeit, unconsciously into the very fabrics of human existence. At the very core of research is the quest for solution to problems, and knowledge acquirement & advancement, which led people to “search again” – according to the etymology of the word [1]. These activities have remained timeless, and interminable. They are the very essence of humanity.

Every research endeavour is primarily aimed at inquests (“*the pursuit of truth*”); either regarding the origin, meaning / purpose, morality / ethics of, and the future perspectives / metamorphoses of certain realities; it is the quest for truth and solutions that spurs these inquests [2].

Theologians and scholars of Religion and Biblical Philosophy have also argued that in some of the oldest, respected and devout accounts of geology and anthropology found in the Bible book of *Genesis* [3], and the Quranic *Suras* [4], it can be seen that even the great Deity – God (or Allah) – in the creation of the earth and humanity itself followed steps and procedures that show some similarity to contemporary research procedures as we can relate to today.

However, as humanity continued to subsist, the need to tackle head-on the challenges and problems faced along the course of existence became evident. But beyond that, and more exigently so, the need to preserve these solutions and the knowledge gained on the path to the solutions for future generations who may encounter such problems or similar,

possibly re-engineered versions of these, became very necessary. Knowledge and solutions now had to be represented in such a more systematic and methodical form that could transcend generations and still retain its value and usability [5]. This need has evolved research to where it is today.

Many scholars and researchers have attempted to define “research”. Some of which include: [6], who defined research as a systematic quest for undiscovered truth, such that knotty problems can be solved in an attempt to push back the frontiers of human ignorance; [7], who defined research as “the culmination and final product of an involved process of research, critical thinking, source evaluation, organization, and composition”; and [8], who defined research as “a process of enquiry and investigation”.

However, despite syntactic variations in the phrasing and wording of the various definitions, the semantics have remained the same; and when in right perspective, it all boils down to two things ultimately – *problem solving, and knowledge acquisition & advancement*. This is because from the etymology of the word (in the online dictionary of word etymology): “*research*” is derived from the Middle French word “*recherche*” which means ‘*to go about seeking*’; the term itself being derived from the Old French term “*recherchier*” a compound word from “*re-*” meaning ‘*again*’ + “*cerchier*”, or “*sercher*”, meaning ‘*search*’. Therefore, by etymological concatenation, *research* could be interpreted also as ‘*to search again*’; and by direct implication, from the origins of “*research*”, the goal is not necessarily in proving or disproving truths and facts, but rather in improving on the existing epistemological (knowledge) landscape. This

arguably has given rise to the cliché “*contribution to knowledge*” that is fast becoming a watchword within the contemporary research environment.

As an illustration, ancient philosophers suggested the earth to be a flat-disk-shaped / planar planet surrounded by a spherical sky floating in the ocean. Later on, around the 6th century BC, ancient Greek philosophers went on to posit that the earth was spherical – a physical given that was not confirmed until around the 3rd century BC when the Hellenistic astronomers confirmed it. The purpose of all these discoveries was not necessarily to contradict each other, but to assert the actual shape of the earth so that expeditions such as the circumnavigation of the earth by Ferdinand Magellan and Juan Sebastián Elcano between 1519–1522 could be a success [9], [10].

In essence, and in holistic perspective, as [5] rightly posited, research is a hunger for knowledge that leads to a diligent search, investigation or experimentation that would either seek to discover and/or interpret new knowledge, or resolve debates and gaps in existing (possibly obsolete) knowledge. From this position, two deductions can be made about what could be termed as “the broad goals of every research”:

- a) Research could seek to either discover new facts, ideas and concepts already in existence, but about which little or nothing is currently known; or re-discover some already existing facts, ideas and concepts that may have become obsolete, relegated, or misrepresented (especially in light of the rapidly evolving technological world);
- b) Research could seek to create very novel innovations / inventions that may either find their use immediately or eventually.

II. RESEARCH PROBLEM IDENTIFICATION, FORMULATION & STATEMENT

Every research activity begins with a question(s). The desire to seek answer to unsatisfied arousals of the mind which may originate through various ways. However, the fact that the question(s) that spur a particular research inquisition may not necessarily be novel to the global knowledge domain apparently necessitates the need for an epistemological traverse. The goal here is to properly contextualize and frame the central question(s) that has / have instigated the research endeavour, so as to have a focus and sense of clarity as to the direction of the research investigation or experimentation; leading to an unequivocal statement of the core issue(s) the research intends to address.

In traversing the related literature terrain to the problem under inquisition, the researcher(s) must first begin with a conceptualization and justification for the problem under investigation. Cardinal to the task of conceptualizing the problem, is the need to have a problem that is clearly spelt out in very unambiguous terms; this is known as the problem statement. The problem statement is the core and

focal point of the research activity as there seems to be a general consensus that the research activity is believed to have ended if and only when the central problem investigated by the research has been solved. Researchers have found themselves having to return to their problem statement time and again during the course of their research endeavours when they feel like they are losing track of the focus of their research.

Beyond this, however, the researcher(s) would also need to provide a justification as to why this problem is necessitating the exigency of study and investigation at such a time in human existence. It is necessary that a research endeavour be able to find a niche in the global solution base of humanity if it is ever going to have any real-world relevance. This is basically important for the purpose of more easily engendering the interest and cooperation of other researchers and fellows in the research problem domain, even though antecedents confirm that some research findings may not find their application domain until sometimes decades or centuries after they have been propounded.

This is in line with the position by [11], that every research project formulation should begin with the research understanding the reason / purpose for the research, the relevance of the research both to the immediate environment as well as the global scene, and the contributions that such a research would hope to make to the existing knowledge domain.

[12], specifies some of the following steps that could help formulate a good problem statement:

- i. Choose a research problem from an already identified area of interest or experience in the field of inquisition – computer science in this case; and there are many broad fields in Computer Science that could appeal to the beginning computer science researcher: Networking, Telecommunications, Computer Engineering, Graphics and Visual Innovations, E-Commerce & E-Business, amongst others. This step is important, amongst other reasons, in order that the researcher may be able to maintain a sustained interest and stimulated imaginations throughout the research endeavour, as it would be based on an area of competence, experience and interest. It is also important to state here that the more concise, descriptive and yet understandable a problem statement is, the better for it; and also the problem statement should be one which empirically adequate and can be researched / tested / validated by some means possible. This, amongst others, would help the researcher to have a clear insight as to what specific area the findings and contributions of the research would be able to fit into.
- ii. Narrow the problem statement down to relate to a specific issue / problem within the field of interest is also of paramount importance. This is known as the scope of the research, and it is important because it

- would help to give clarity of perspective to the research and also help guide the literature search to stick to that which is relevant to the focal research discourse. Also, because the landscape of problems requiring investigation is unlimited in comparison with the very much limited research efforts, it may be necessary that the research problem be one of relatively immediate importance and urgency, and one with a not-too-distant usefulness and social relevance.
- iii. Understand the origin of the problem of interest: whether it is based on personal experience, casual observation, a general opinion of other experts within the field of interest, deduction made from related theories, insights received from literature searches, or limitations and gaps of current knowledge in the area of interest.
 - iv. Evaluate the relevance or potential of the problem for study or investigation, especially in light of whether or not it is sufficiently new / unique, and whether findings would be novel enough to make a relevant contribution to existing knowledge; also considered should be whether it would be able to engender sufficient interest that would lead to further research in the future; whether the researcher(s) have sufficient knowledge and expertise in the area to drive the research to completion within the specified time for the research
 - v. The problem statement must exhibit clarity of research intent and directions, as well as proper contextualization of the problem scope and operationalization of the key terminologies in the research discourse.
 - vi. The problem statement should be properly balanced within the far end of triviality and the other extreme of overt sophistication and complexity; and the researcher should be convinced that it is possible that the research be completed in within the required and available resources of time, facilities and finance.
 - vii. Format the problem statement in such a form that is jurisdictionally acceptable for the research scope / domain / jurisdiction. The problem statement could be formatted either in the form of a question (which depicts an inquisition into how two or more variables interact), a statement (which describes the scope of the work), a hypothesis (which seeks to measure the statistical relationship between variables of interest), and/or an objective (which states processes that would lead to the solution of the research problem in terms that are Simple / Specific, Measurable, Attainable / Achievable, Realistic and Time-Bound [*S-M-A-R-T*])
 - viii. The problem statement should be stated in such a form that depicts that it is researchable
 - ix. The problem statement should be feasibly understandable to others (research stakeholders) in clear and concise terms

Following the identification and clear statement of a research problem, a matter of succeeding exigency is to define exactly and clearly mark-out the pathway to the

solution to the research problem. This is known as the statement of the research aims / objectives. Research objectives are important because amongst other reasons they help to precisely checkpoint the pathway to the solution to the research problem. They provide some form of waymarks (in the form of checkpoint deliverables) that would help the researcher keep on course and maintain steady progress towards the research solution.

Illustratively, see research objectives like the several stages in a typical computer video game; at the end of each stage is a checkpoint that reveals to the game player the game stats and progress made so far, and sometimes further rewarding the game player at the end of each stage with a playing bonus (what may be seen in research as a deliverable); all of which synthesize towards the goal of finishing the game to the end. In the end, the research objectives should have in some way been able to cover all the different aspects of the problem area, as well as its contributing factors in a coherent and logical sequence of steps that would lead to a solution to the problem. Perhaps this accounts for why in most cases it is required that be written using action verbs to define courses or paths of action.

[13], suggested that research objectives should be S-M-A-R-T; that is they should be:

- a) Simple / Specific – They should clearly and unambiguously written; stating unequivocally what is expected to be achieved.
- b) Measurable – There should be some indices, whether documented or perceived, by which it can be objectively measured, evaluated or quantified so that it is clear to the researcher(s) when it has been achieved.
- c) Achievable / Attainable – The objective written must be such that has taken into consideration the framework of available resources for the research, and can still be deemed as being actualisable within such framework.
- d) Realistic – Objectives should portray a logical appeal to metaphysic, especially in light of what is obtainable within the context current global landscape.
- e) Time-Bound – Specific time periods should be specified, within which a certain objective or set of objectives is hoped to be actualized.

Some schools of thought tend to strike a dichotomy between what should be referred to as a research aim and a research objective. The crux of this dichotomy is centred on the reasoning that every research activity should be propelled by a cardinal desire to solve a particular problem for which some metaphysical or experiential justification has been arrived at by the researcher: this is seen as the aim of the research; the research objectives then being the various stages / steps / checkpoints that would be covered on the journey to arriving at a solution to the problem – which is the aim of the research. However, whether such a dichotomy purports any real existential relevance or procedural implications to the actual research process is a debate that is still ongoing.

III. LITERATURE REVIEW

Two key abilities that are cardinal to a successful literature review are: *analysis and synthesis*. These are based on the ability to of the researcher to comprehensively and critically break up concepts and knowledge into their very simplest and most fundamental compositions and assumptions; and then aggregate these knowledge in right context, bridging across various other similar / related sources (secondary sources) to the central research discourse, in order to eventually produce an erudite synthesis of the focal points and issues in the epistemology of interest, for the purpose of making an unequivocal case for the research endeavour.

Even though in most typical and contemporary cases this research activity is relegated to much later on in the research endeavour, this stage should be arguably one of the very first stages in the research process. A literature review not only helps to give the much-needed focus and clearly inform a lacuna(e) that eventually translates into a niche from which the researcher can relevantly contribute to knowledge, but it also arms the researcher with the very basic to advanced erudition (depending on the depth of literatures covered) on the rationale and background of the study, as well as the status of the current epistemological landscape within the research area [14]. All these are needed in order to relate at a level of expertise that would not trivialize the most vital discourses and issues under deliberation within the intended research area / domain. This was, no doubt, part of the sense in what Sir Isaac Newton meant when he said “If I have seen further than other men ... because I have stood on the shoulders of giants.”

Sometimes, the task of reviewing literatures could be cumbersome, rightly so because of the extent of critical thinking that is required for a successful analysis and synthesis of secondary literature needed for an outstanding literature review. [15], provides a three-pass approach that could be very helpful in the task of covering considerable amounts of relevant literatures in good time while not missing out on any of the main concepts.

The literature review typically comes after the introductory section of the research, and right before the chapter on the research methodology; and is a critical composition of already published facts in existing literature. However, in some cases, naïve young researchers have found themselves entangled within webs of unverifiable and untrustworthy sources that were used within their researchers, and ended up dragging the research into the mire. This has generated the fundamental discourse within research of “how can one filter out non-credible from credible information during the course of literature review, especially in light of the reality of a ‘free zone’ such as the Internet that has formed an indispensable part of most research endeavours?”

In light of this, there seems to be a consensus of suggestions positing that to avoid being entangled within such webs it is safer to stick to accredited database sources and research

repositories (such as Google Scholar, ACM Digital Library, IEEE Digital Library, etc. for the Computer Science researcher) when seeking sources for a literature review. One rule of thumb that works quite reliably within the sphere of information gathering is to try to answer the question, “what information source would be most adequate and credible to carry the type of information I seek?” Then go directly to that source to look for the needed information. As an illustration, there is no more credible source to carry information relating to the latest releases of Microsoft operating systems than the official website of Microsoft for Press Releases or Technology News (TechNews); neither is there a better source to carry information relating to the recent outbreak of a global epidemic than the official website of the World Health Organization (WHO). Beyond that, some sources that could also provide credible information for research activities include: peer reviewed journal articles, research monographs, peer reviewed conference proceedings, specialist textbooks and reports, scholarly discussions by experts in certain areas at seminars and workshops, scholarly professional magazines and periodicals, etc. [16].

Composing a good literature review is a great deal of work, because it arguably tests and confirms very extensively the honesty, integrity, abilities and capabilities of the researcher [17]. Because most of the information that is used within a literature review are primarily secondary information, this places on the researcher the requirement to give other authors of secondary literature due credit for their intellectual work in the form of references (which are usually placed at the end of the research work) and citations (which are placed within the body text of the research work in other to substantiate the various claims made within the body of the work). Section IV throws a further light on the subject matter of crediting research sources.

Literature reviews are made a much easier task when researchers bring to the task a research question that they seek to discover more deeply, appraise, contextualize and then synthesize in light of the evidences that are hoped to be discovered from the secondary literatures. In light of this, literature reviews according to [18], could be of the types: Evaluative Reviews, Exploratory Reviews, and Instrumental Reviews.

IV. RESEARCH FORMULATION, DEVELOPMENT AND WRITING

In the process of trying to formulate / develop a research plan, a research proposal is an indispensable component. A research proposal presents a structured, holistic perspective of an intended research work from conception to completion. According to [19], it is a document that outlines a research problem / topic, states the associated research questions, summarizes the prior literature related to the topic, and specifies the procedure to be followed in answering the research questions. In the same vein also,

[20], defined a research proposal as a written description of a project that is yet to be done.

Though often usually misunderstood in terms of its purpose, it has often been said that “a research is usually as good as its proposal”, especially when the research idea is intended to engender the interest and possible collaboration / sponsorship and third party. Especially for the purpose of engendering sponsorship, the research proposal should be able to convince potential sponsors as to why the research activity may be a worthwhile investment. As a result, formulating, developing and writing a good research begins with a well-written proposal enriched by knowledge gained through strategically guided literature search. The clarity, motivation, imagination, and vision behind an idea usually endears third party to participate and register interest on the side of the research; as a result, therefore, the critical mindedness of any third party possible that may come in contact with the research must be put into right perspective, especially when proposals are required to be submitted for various shortlisting purposes [21]. In essence, a proposal may be considered important for the following two amongst other reasons:

- a) They may be written as a selling point for an intended research, to show that it has been circumspectly considered and thoroughly strategized; and that all possible situations and issues have been well anticipated. This would help third parties (collaborators, sponsors and stakeholders) to more easily figure out whether the intended research is worth their investments in terms of efforts, finances and time.
- b) Researchers may also write proposals to help them view their intended research more holistically, in order to be able to more adequately strategize, plan and organize resources so as to complete the research within the stipulated time.

Though there is no standard or global specification regarding the length of a research proposal; but then, recognizing the fact that not so many research stakeholders have a lot of time on their side, it may be just reasonable to say that the shorter a proposal is, the better for it. The point of emphasis here is that it should be concise, clear and brief; written in lucid and simple yet technical language; and appealing and erudite enough to be able to inspire the confidence and interest of the stakeholders [21]. In some submission cases, the templates and formats for proposals are specified and made available, in which cases the researcher should do well to adhere to such a template / format specification. However, in a case where such is not provided, a general template that the researcher could follow is this:

Title: This is the name (at this point may still be a working, and not a finalized one) given to the study. It is one of the first points of call for the study, and usually one of the cardinal points that are used to index or advertise the research. It should be concise, descriptive, and yet captivating for it to be able to meet its desired purpose.

Every research title usually starts out as a topic or subject area, from which it further gets streamlined and structured until it becomes a title. A successful research title is one that is able to capture the interest of the reader enough to arouse inquisition and draw the individual into reading the rest of the research [11].

Abstract / Executive Summary: This is usually a brief summary of the research of between 250 – 300 words, and usually includes a brief introduction / background to the problem area, the problem statement, research question(s) and hypotheses (should there be any), the research justification / rationale behind the study, the methodology that is intended to be deployed in investigating the problem under study so as to emerge with the expected results [22]. It is important the abstract is as concise, yet descriptive and captivating as possible because in most cases, for some very busy readers, the abstract / executive summary may be the only part of the research that they may ever get to read, except it convinces them enough to go into the body of the research [23].

Introduction: This section discusses the background to the study quite extensively in a bid to create for the reader a concise erudition into the way the research problem landscape emerged from a certain point in time past to where it is today, leading to the statement of the problem currently under study – covering the extent of the problem and its current status. Also in this section there is the justification for the study and then a strong case covering the significance that the proposed research is expected to lay claims to, in relation to the current, existing body of knowledge in the problem domain. In all, this sections helps to convey to the reader the proper context within which the research would be conducted.

Literature Review: Though section III of this write-up has dealt extensively with the conceptualization, content, and layout of this section. In some cases of proposal writing, the literature review may be written as a part of the introduction section, however, it could also be written as a separate section in other cases. But then, the goal remains the same in both cases: demonstrate the erudition of the researcher in the research area as well as the theoretical and conceptual discourses that relate to the research problem under study, reveal a lacuna (e) from which the researcher intends to contribute to knowledge, showcase the ability of the researcher to critically traverse literature and synthesize fundamental concepts to make cases for the research position.

Methods / Methodology: This is one of the most important sections of the research, as it tells the research stakeholders how the researcher has planned to tackle the research problem. It describes the action plan and activities that would lead to an effective and efficient completion of the research. The cardinal issue here is that the described method / methodology should be systematically and vividly described in such a way that it provides sufficient information to enable the reader determine how empirically,

epistemologically and metaphysically sound the intended methodology is. Some researchers even suggest in some circles that the methodology section of a good research proposal should contain sufficient information for any other qualified researcher to be able to implement the study independently; however, the implications of this position is a debate that is still going on in the world of research. Also expected in this section is that the researcher demonstrates a knowledge of alternative methods that could lead to a solution to the same research problem under study, and then provide a justification as to why the chosen method was preferably selected for solving the research problem [5]. In describing the preferred research methodology, the researcher may elucidate on the research design, procedures, research instruments, samples, etc.; Section V of this write-up discusses more issues relating to research methodologies.

Expected Results: Even though the research is still not concluded, it is believed that a part of the erudition which stakeholders of the research proposal would like to identify with is the ability of the researcher to anticipate the possible result(s) that is/are expected to have been achieved at the end of the research process. This expected erudition could be usually only be made possible after a proper, extensive and systematic literature review that provides some insights into the types of data that will be collected, the types of responses that will be received, etc. [11].

Discussion: This is the point at which the researcher convinces the reader about the potential / anticipated impact and value of the proposed research. This section would do well to be communicated enthusiastically and confidently, while trying not to exaggerate the perceived merits of the intended research or make assertive claims about a research that has not possibly even been commenced yet. This, perhaps, accounts for why it may be wise to also mention the possible limitations and weaknesses of the proposed research, which could usually be justified with reference to the time and financial constraints for the research, as well as the fact that the research is still at its early / developmental stage and also the expertise of the researcher in the research area [21].

Research Budget: This section highlights descriptively the financial needs and resources that should be provided / availed in order for the project to succeed. It also describes how these resources, when availed, would be systematically and efficiently put to use to see the research to completion. It is more or less a pricing metric for the research work.

Project Timelines & Deliverables: This section clearly indicates the estimated time frame (or resources) of the research, as well as how the time resources would be efficiently and effectively proportioned to meet with the exigencies of the various sections and parts of the research activities and processes. It may also be expected in this section that the various milestones / tangibles that are expected to have been completed at each point along the research project timeline also be mentioned within this section.

Ethical Issues & Considerations: This sections helps to prove to the reader / stakeholder of the research that the researcher has taken into consideration the ethical implications of the various phases of the research: from the techniques to the methodology and design, as well the research reporting / writing / documentation. No stakeholder would want to identify with a research that would have ended up violating fundamental human rights by the time it would have been completed. Read section VI of this write-up for more information about this proposal section.

References / Bibliography: This section lists the authorities and sources (books, journals, and articles) that were used to inform and substantiate the claims and positions made by the research / study. Many formats have provided various specifications for standardizing such a list, such as the American Psychological Association (APA) style, the Modern Language Association (MLA) style, the Chicago / Turabian Style, the Harvard Style, as well as the Institute for Electrical and Electronic Engineers (IEEE) style, amongst others. However, within the circles of Computer Science and Information Technology, the APA¹ and the IEEE² styles have been discovered to be the most widely used. It would be equally important though that researchers also familiarize themselves with the jurisdictional / institutional / professional reference specifications that they may sometimes be required or expected to adhere to.

Appendices (if any): This sections would contain any extra information or document relating to the research, which could not be properly fitted into the body of the research write-up. These may usually include: clearance letters, consent letters, questionnaire samples, tables, images, and graphs, etc.

The ordering / arrangement of these various sections of a proposal is not set in stone and may be reordered, cut-down, scaled, added to or removed from across various jurisdictions. However, what should make sense is the fact that despite the arrangement / formatting that the researcher may be faced with for the drafting a proposal, the goal of the researcher should be to exhibit an erudite, seamless flow of thought in writing that would showcase organization, coherence, responsibility, honesty, and definiteness, which would be able prove to any prospective stakeholder that the research is already and imminent success.

[26], posits that research proposals are generally of seven (7) types:

- i. **Solicited / Called-for / Requested Proposals:** These proposals are written in response to a call or solicitation made by a (prospective) research sponsor, guardian / supervisor, or stakeholder. Usually, formats, specifications as well as terms and conditions for this type of proposals are clearly spelt out and most times

¹ For Further Guidelines, see [24].

² For Further Guidelines, see [25].

- must be adhered to before the proposals could even be received / considered.
- ii. **Unsolicited / Arbitrary Proposals:** These proposals are written arbitrarily to spark the interest of, and for possible consideration by (prospective) research sponsors, guardians / supervisors, or stakeholders. Because they are usually not solicited, researchers could structure them using any format of choice in line with the basic specification of proposal; however, it must be borne in mind that such proposals have a higher probability of being summarily discarded should they fail to capture the anticipated interest.
 - iii. **Pre-Proposals:** These types of proposals are usually structured in form of a letter of intent or a brief abstract, and are usually solicited. Prospective sponsors / supervisors sometimes require this in an effort to save the researcher from writing a full proposal that may not capture their interest. When pre-proposals have been approved and positively considered (usually based on excellence, confidence and clarity of intent), full proposals could then be requested for.
 - iv. **Sequel / Continuation / Non-Competing Proposals:** These types of proposals are written as a follow-up proposal to an initial proposal for which funding, sponsorship or guidance may have already been granted. It is more or less a progress report to show sponsors / guardians that steady progress is being made in the research work, and that resources and funds are being efficiently and effectively utilized.
 - v. **Renewal / Competing Proposals:** These types of proposals are usually written to convince same sponsors or prospective sponsors to further support a research that may have failed to meet its preset deadline often due to reasons of either insufficient time or financial resources. **Note**, however, that such proposal are viewed and treated by sponsors as unsolicited proposals and sometimes have a lower likelihood of being successful.
 - vi. **Supplemental Proposal:** These types of proposals basically request for extra support in order to extend or expand the scope or protocol of a project within a current budget period, or to meet up with increased administrative costs that were not seen as at the time of the new, non-competing continuation, or competing continuation application.

Sometimes, research proposals may be seen to traverse across one or more of the above proposal types depending on the circumstances surrounding the submission or filing of the proposal.

V. RESEARCH DESIGN, METHODOLOGY & TECHNIQUES

The choosing of an appropriate research *methodology*, and structuring of the associated *techniques* to fuse perfectly with the *methods* that would be used to approach research

processes in such a way as provides the most effective path to solving the central problem of the research, is an activity which in entirety is referred to as *ResearchDesign*. Sometimes a correct, systematically, and properly engineered research design could make the difference between an effective and efficient, timely-delivered research which solves or could solve a real-world problem, and a laggy, unnecessarily-prolonged, resource-wasting one that has no real-world usefulness. Designing the study or research effectively so as to efficiently utilize scarce and limited research resources lies at the core of a well-structured research methodology [5].

[27], described the relationship between research methods, methodologies and techniques. It was posited that research techniques are the behaviours and instruments that feature in research processes; while research methods are the behaviours and instruments that inform the selection and construction of research techniques. A fusion of a correct research method with the right research techniques makes up a research methodology. As an illustration, in trying to carry out a research focused on studying “intra-network malware behaviour and characteristics”, a Computer Science researcher could consider using the techniques of observing network traffic for anomalies using network stat applications, collecting / spoofing packets from various routers within the network, analysing information from the quarantine pool and virus vaults of resident anti-malware applications, as part of the methodology for fulfilling the research objective of investigating the characteristics of intra-network malware and their effect on network performance. These two together would be discussed as part of the methodology(ies) for the research.

Every research activity falls under one or more of four major classes which define and proffer the approaches to strategic and systematic research design based on different viewpoints to the quadrilateral discourse [27], [28]:

- I. Applicatory research
- II. Objectives-inspired research
- III. Inquisition-based or Empirical research
- IV. Reasoning / Logic-based research

The **Applicatory Research** design class views researches in terms of its real-world implications and use. Here, research methodologies could either be *pure / basic* (where the study / research is not necessarily seeking to solve a current or future problem, but basically to test, re-test, or confirm theories or create new paradigms to solving particular problems); or *applied* (where the study / research is targeted specifically to solve a current, practical problem; some sources refer to this as an Intervention research / study). More often than not, however, it has often been found out that applied researches rely on the findings and information from basic researches in order to be able to tackle current problems more systematically and knowledgeably; little wonder [29], said it rightly so: “[I]t is probably a mistake to view the basic-versus-applied distinction solely in terms of whether a study has practical applications, because this

difference often simply boils down to a matter of time. Applied findings are of use immediately. However, there is nothing so practical as a general and accurate theory.” (p.107)

The **Objectives-inspired Research** design class views researches in terms of the goals that are sought to be achieved by the research, which usually revolves primarily around testing / establishing theories using various approaches in order to propose solutions to a problem to question. Here, research methodologies could either be *descriptive* (when the goal is to systematically analyse and describe situations, paradigms, phenomena, etc.); *correlational* (when the goal is to establish an interdependent relationship between two or more variables in a particular discourse); *explanatory* (when the goal is to ultimately provide an interpretation / clarification about certain aspects of a particular discourse); or *exploratory* (when the goal is to identify / define a question or problem or seek to elucidate on an area of discourse about which little or nothing may have been previously known). In most cases, however, studies usually incorporate one or more of these categories in order to arrive at a more standardized and widely applicable result.

The **Inquisition-based Research** design views studies based on the nature of the approach to the inquisitions, which usually have as the goal the need to test and analyse the feasibility of a proposed / existing research solutions based on empirical evidence. Approaches used here could either be *quantitative* [or empirical] (where the research inquisition is designed in such a pre-determined form as makes possible the statistical (and/or mathematical) quantification and measurability of various key aspects (inputs and outputs) of the research process. Various statistical and mathematical analysis tools and approaches [such as regression and correlation analysis, and numerical modelling] make the quantification possible so that solutions could be intelligently proffered based on empirical outcomes / findings. Quantifiable inputs and outputs that are common in this approach include: the research questions and responses, research sampling, research data collection and interpretation, research results and findings, etc.); or *qualitative* [sometimes called *interpretive* or *constructive* or *non-empirical*] (where the research is structured more like an explorative inquisition into a problem domain, without necessarily desiring any quantification of the research inputs or outputs; qualitative researches are entirely centred around the discussion and/or interpretation of new or existing theories, laws and propositions). Arguments exist, however, about the possibility of combining both the quantitative and the qualitative approaches in a new approach known as the *mixed* approach which is commonly used in Computer Science (CS) researches, because of the fact that results within the field of CS may not always be based on empirical evidence; however, conclusions must still be objectively argued and clearly defined.

Furthermore, the quantitative [or empirical] approach to inquisition-based researches could also either be *inferential*

(when data is collected, either from primary sources (by the researcher personally) or from secondary sources (already existing / previously collected data), in order to acquire needed information to make informed inferential positions and conclusions about the status of the entity(ies) or group under investigation); *experimental* (when an actual real-world research environment is created, infused with prevailing real-world conditions, and then controlled in order to observe the relational effects of variables under study by manipulation their conditions within the research environment); or *simulation-based* (when an artificial or virtual research environment is created for the purpose of making critical research observations by manipulating inhabitant variables, or to draw conclusions based on the analysis of data gathered from the research environment; some sources may also refer to this as a quasi-experimental research approach).

Also, the qualitative approach to empirical research could either be based on [30]: *relativist ontology* (where various aspects of reality, situations, problems and occurrences are viewed in subjective inter-relational perspectives to each other, through meanings and understandings that have been formed from the researcher’s social interactions or experiential dimensions in order to arrive at solutions or truths); or *transactional or subjectivist epistemology* (where the various facets of the knowledge existing in epistemology about a subject area or an object of research interest are put together in such a form that can generate an insight for the researcher into how people think, understand themselves, others and the world around; so as to be able to create an informed solution to a problem that would be seen as empirically adequate). Within this qualitative research framework, findings and knowledge emerge as the inquisition proceeds and truth is negotiated to be arrived at through ethical³, pragmatic and scholarly dialogues and discourses. Every truth, finding or solution arrived at within such a framework is usually contextual, situational, and time-limited; that is, they are and should be open to re-interpretations, re-positions, as well as new dialogues and debates within the provisions of the same framework [31], [32]. This is what is referred to within the context of this write-up as empirical adequacy.

The Reasoning / Logic-based Research design class views studies based on the logically consistent approach to reasoning that would be employed towards providing solutions to the research problem. Methodologies / approaches used here could either be *inductive* (where the researcher(s) seeks to collect and analyse substantial amounts of data on a subject / object of research, in order to develop patterns that could lead to the development of theories that would be reasonably applicable to every occurrence of such a pattern on a generic scope); or *deductive* (where researcher(s) make assumptions / propositions from a generic scope based on inferences

³ Read the entire section VI for insights into what is ethical within the framework of research.

posited from patterns observed in substantial amounts of collected data, and then tailor such assumptions in a manner that is logically applicable to a specific occurrence) [33]. In essence, the inductive – deductive research design terrain is more or less a narrow-to-broad and broad-to-narrow landscape.

In the choosing of methods and constructing the associated techniques for research activities, there are ethical requirements that must be taken into consideration in order to stay safe of litigation that could emerge as a result of unethical / unprofessional practices incorporated during the course of the research; and also to portray the final, obtained results as having been arrived at using high standards of global research ethics and professional practices.

VI. RESEARCH ETHICS, IMPLICATIONS & CONSIDERATIONS

Following the choice of methods, formulation of techniques for research, and before research findings are made public, the most fundamental ethic which must be considered, and that is often the bone of contention in the litigation that follows the publication of research findings and positions is concern for the research participants – whether or not their rights as participants (individuals or organizations) were respected. Such participants usually fall under two categories: *Direct* (those that are directly involved in the research process – entities being observed / monitored, respondents, co-researcher(s), etc.) or *Indirect* (those that are not directly involved in the research process – reviewers, end users, readers, etc.) [34].

Here, the data protection rights of the participants must be considered, as well as their intellectual property rights, restrictions on the kinds of technology that are allowed for use in research, and legal liabilities of software developers – all these are fundamental legalities that must be considered by the ethical researcher in choosing methods and structuring techniques for research. The ethical researcher must also take cognizance of the following rights of the participants not to violate them at any point during the course of the research: the right not to participate, the right to withdraw from the research at any time and for any / no reason at all, the right to give informed consent, the right to anonymity if so desired, the right to confidentiality if so demanded. It is also often required that these rights be repeated or fore-disclosed to participants prior to commencing the research, so that participants know what their rights are and can rightly identify when they are being violated [34].

In lay terms, *ethics* refers to moral standards governing human behaviour, actions, and choices; or a discipline that studies the rightness or wrongness of these behaviours, actions and choices.

Scholars of ethics generally study ethical principles from the paradigms of normative and prescriptive ethics. From the

viewpoint of normative ethics, ethical principles are derived from consistent and well-based standards of right and wrong that stipulate and inform human choices, decisions and actions in terms of rights, obligations, benefits of the common good, fairness, as well as other specific virtues. In light of this, ethics would include such standards as relate to reasonable obligations to refrain from rape, stealing, murder, assault, slander, and fraud; standards that also inspire virtues of honesty, compassion, and loyalty; as well as those relating to fundamental human rights [35].

From the viewpoint of prescriptive ethics, ethical principles relate to personal and communal ethical standards, associated with behaviour, feelings, laws, social habits norms and mores that could deviate from some more universal ethical standards, thus necessitating the need for constant review and overview of such standards to ensure that they remain congruent and in line with the progress and continuity of humanity [35].

In essence, Ethics is grounded in the notion of responsibility and accountability. This directly translates to the reality that individuals, organizations, and societies, as free moral agents, are responsible for the actions that they take and hence should be held accountable to others for the consequences of their actions. This accounts for why in most contemporary societies, a system of laws clearly define the most significant ethical standards and provide mechanisms for holding people, organizations, and even governments accountable [36].

Within the academic and research circles, various ethical committees and departments have also been set up to guide scholars towards maintaining sound and globally acceptable ethical principles and practices in the execution of their research activities.

A. Academic Freedom in the Ideal Research Environment

In trying to define the Ideal Research Environment: it is any environment that fosters the activities that encourage the inquisition into knowledge and truth, especially through such propensities as teamwork and collaborative knowledge exchange, mutual respect & accountability, honesty, integrity, responsible autonomy and ethical compliance.

In addition, while it has remained the goal of many teaching and research institutes and organizations to achieve and maintain such an ideal research environment where solutions would originate from sheer, passionate inquisitions into various universal phenomena, driven by dedicated collaboration and adherent to universal basic principles of ethics and morality, quite a good number of these organizations are still a long way off. In the subsequent sections of this writing, the ethical requirements in teaching, learning, research and choice of research methods would be elucidated; also discussed would be the nexus with legality (legal ethics).

Every scholar / researcher (student and teacher alike) is (and should be) entitled to the right to “Academic Freedom”. [37], defined Academic Freedom as “the freedom to teach, study and pursue knowledge and research without unreasonable interference or restriction from law, institutional regulations or public pressure.”

Under the specifications of this right, scholars have the freedom to be led into inquisition into any subject of interest triggered by intellectual perturbation; and present and publish results, data and conclusions without any external influence / censorship – disseminating knowledge in whatever manner is considered most professionally adequate to them, so long as it violates no other widely acceptable professional, ethical, moral or legal constraints, standards, or legislation (responsible autonomy) [37].

Towards maintaining Academic Freedom in the Research Environment, especially within the context of responsible autonomy, the principle and practice of ethical teaching and learning this environment places on the scholar the requirement to seek answers to the following questions in every academic pursuit [37]:

- ✓ Does this bring people closer to the truth? (Honesty)
- ✓ Could this foster constructive debates based on mutual trust and respect? (Trust & Respect)
- ✓ Would this be able to engender the interest and participation of more people? (Team Work & Collaboration)
- ✓ Would this be considered fair to all? Or at worst, the majority? (Utilitarianism)
- ✓ Is this justifiable by even the highest known standards of character and morality? (Integrity)
- ✓ Does this represent the highest known standards of behaviour and conduct? (Responsibility)
- ✓ Is this compliant with what is legally obtainable / allowable / excusable? (Legality)
- ✓ Would this be able to become as widely known as possible? (Communication)

However, due to the concern of advancing knowledge and solving problems at the expense of humanity and the person seating next to you, there came to need attach some global standards and ethical requirements to the pursuit of knowledge; even as the great German philosopher – Albert Einstein – rightly captured it during a speech at the California Institute of Technology, on February 16, 1931, “it is not enough that you should understand about applied science in order that your work may increase man’s blessings. Concern for man himself and his fate must always form the chief interest of all technical endeavours; ... in order that the creations of our mind shall be a blessing and not a curse to mankind.” – [38].

B. The Ethics of Legality

Robert Tappan Morris, a doctoral graduate student of Cornell University, became the very first person to ever be prosecuted in the United States in 1990 for a cybercriminal-related offence under the US Computer Fraud and Abuse

Act (CFAA) [18 U.S.C. Section 1030]. During the course of his doctoral research, the experimental malware which he was using for his research investigation leaked on the production network and got on the Internet in November 1988, putting out about 6,200 computers in the United States alone. Even though Morris, according to some sources, out of his innocent and good intentions, was the one who called and alerted the network administrators of the presence of his malware – the Morris / Internet worm – on the network, the Computer Fraud and Abuse Act (CFAA) [18 U.S.C. Section 1030] at the time, made illegal the distribution of computer code or placing it in a commercial stream; especially if it is intended to cause economic loss or damage. In 1989 Robert Morris was indicted due to the activities of his worm which resulted in productivity losses valued between \$200 and \$53,000. He was sentenced in December 1990 to three years of probation, 400 hours of community service, and a fine of \$10,050 including the costs of his supervision [39].

The case of Robert Morris is an illustration of the sense behind the dichotomy which [40], struck between ethics and law in what would be referred to in this write-up as the “Ethics of Legality”. The core of the discord in the ethics of legality is based on the fact that most times while executing a research, researchers tend to base the analysis of whether the research activities are ethical based on the view of whether it does “harm” to any other. When this could be perceived as not being the case, they researchers readily arrived at the conclusion that the research was most likely ethical, “or at least acceptable within the research community” [40]. But the real challenge is that not all ethical (or “harmless”) research activities are legal; because legality is not administered based on the simple notion of “harm” or “no harm”. It is a more complex terrain.

Illustratively: on the one side of the coin, as a help desk / support professional, going through the personal / confidential files of a user who brings in a machine for repairs or troubleshooting, and going on to keep copies of some of the users’ files without the consent of the user (even though with no imminent / prospective malicious or nefarious intent in mind at the time) is an illegal action, even though it may not necessarily have caused any harm to the user, and there was the possibility that the user may never have found out. This is an example of one seemingly “ethical / harmless” practice that is illegal. On the other side of the coin, one common practice within law enforcement circles in recent past was to obtain evidences, confessions and testimonies from crime suspects using very inhumane and sometimes gruesome brutality and torture. These testimonies were usually accepted as prosecutable in the court of law, without concern for how they were obtained until recently when global outcry forced some government to begin to illegalize such methods of obtaining confessions. This is one example of a method of arriving at a needed solution / answer that, even though, did not pass off as ethical by any standard, was legally tenable in most jurisdictions until recently. As for whether it may be possible to find an ethical situation (or illustration) that may

not pass of as legal is a debate that is still ongoing, and for which there are no clear markers just yet.

As a precautionary measure therefore, researchers are encouraged to seek legal counsel even beyond mere ethical clearance before embarking on research activities. This is all the more important for such research activities as would be dealing with private or otherwise sensitive / classified information during the course of the research process.

VII. RESEARCH DEVELOPMENT, IMPLEMENTATION TESTING & REPORTING

After an appropriate and systematic research design approach has been chosen, the researcher(s) is / are now ready to begin the actual development or implementation of the proposed research solution. This is the point at which the researcher(s) comes up with the actual solution to the research problem. In the field of Computer Science, the end product of this phase could be a hardware or software system, a new concept, theory, law or paradigm, a re-interpretation of previously known facts / statistics, or a new research discovery or dimension.

Sometimes, however, at this stage, a researcher may find out that the results or solutions that were expected to emerge at the end of this stage may have run out of order possibly due to some previously unforeseen problems that occurred at the point of implementation, or a previously unforeseen or misinterpreted cardinal fact / statistic that may have been ignorantly left out during the process of the project development / implementation. The natural tendency here is usually to try to manipulate / twist facts and obfuscate / truncate results so as to portray that the expected solution was actually arrived at. However, in light of the first question of academic freedom which asks whether a particular research brings people closer to the truth or not, the researcher should be able to understand here that manipulating results of research process is a fundamental abuse and misuse of Academic Freedom that could end up sending researchers down the wrong path in the future, distorting truth and confusing knowledge.

Actual implementations of research projects should be tested to confirm that the project or proposed solution actually solves the research problem, and the actual results should be cross-checked in line with the expected results. This should be reported with honesty and objectivity, in the spirit of the right use of academic freedom.

The final reporting or documentation of the research may be required to follow a strict specified format in some cases, but this is entirely jurisdictional; usually for the purpose of uniformity of research documentations within the jurisdiction. Researchers should therefore do well to document their researches in line with that which is jurisdictionally acceptable and required of their research.

VIII. RESEARCH DISSEMINATION AND MARKETING OF INNOVATIONS

Dissemination of the research findings / innovations is often likened to an athletic track event that has present a panel of judges (usually experts) whose duty it is to determine who the best athletes in the track event are, and a crowd of spectators waiting to cheer or boo at the announced winner(s) depending upon their perceptions of his/her performance. This is illustratively analogous of what happens in the dissemination of research results and findings.

Researchers often have to submit documentations or reports of their research findings to a panel of journal reviewers who are seen as experts (or peers) in the research area that is published by the journal. These then go through the documentation, which usually has to compete against other research documentations within the same research area for an often limited chance at publication in what is known as a review process. Criteria that are considered during the review process of a research often include: extent of originality / uniqueness of research, novelty of the research findings and results, relevance of the contributions made by the research to the existing body of knowledge in the research area, the perceived usefulness of the research findings / solutions in reality, amongst others. The review process is usually either blinded (where information about the researcher(s) are not allowed to appear on the documentation under review) or not (where information about the researcher(s) are allowed to appear on the documentation under review). The essential argument in favour of blinded peer reviews is to prevent biases in the review process and ultimate decision. Review process may also often exhibit a multi-staged, loop (repeated) pattern.

Research documentations that emerge successful from the review process are published in academic / scholarly journals which are usually used to disseminate information to experts and stakeholders within a particular research field(s). Journals are often rated based on a metric known as Journal Impact Factor (JIF), which is fundamentally a metric that measures the extent to which professionals, researchers and other stakeholders within the research field(s) published by that journal are citing, referring, and using information from the journal. So basically, the higher the JIF, the better or more respected the journal is as an authority within the research field.

A. *Intellectual Property Rights and Copyrights: Infringement and Law*

The World Intellectual Property Organization (WIPO) defines Intellectual Properties as creations of the mind / intellect, for which a monopoly of ownership, production and/or use is assigned to certain individuals or organizations designated and approved formally by law as owners either for a period of time (in which case they would be known as “related rights”) or for a lifetime. Such creations could be in

form of inventions, literary and artistic works, and symbols, commercial names, symbols and images. Usually, owners and creators obtain copyright automatically as soon as their works are made public, whether or not they apply for it. However, some countries go the extra mile to establish organizations or systems for the optional registration and consolidation of works having copyrights within her jurisdiction; but this is usually for the purpose of facilitating the proceedings associated with the transfer / assignment of rights, financial dealings and disputes relating to disbursement of royalties, as well as settling disputes regarding ownership or creation [41].

Intellectual Property are essentially either of the Industrial Property or Copyright types.

Industrial Property includes patents held for trademarks, inventions, industrial & product designs, geographic markers, etc. Copyrights includes rights held for literary works (novels, plays, and poems), films, musical compositions, sound recordings, artistic works (photographs, drawings, sculpted works, and paintings), choreography, architectural designs, maps and academic / scholarly publications, reference work, newspaper and their articles, computer software, databases / repositories; however, copyrightable works are not limited to these. "Rights related to copyright include those of performing artists in their performances, producers of phonograms in their recordings, and broadcasters in their radio and television programs" [41]. These are known as related rights.

Copyrights are closely related with the legal field of "related rights". The provisions of related rights show some similarity with those of copyrights, only in a more limited way, and oftentimes for a shorter duration of time. Copyrights and related rights could be transferable, in which case they are handed down to heirs / successors, known legally as "right holders". Amongst other things, they grant these right holders the permission to authorise (upon an agreement) or deny the production / reproduction of the work in various forms, public performance / viewing of the work, recording, broadcasting, translation of the works into other languages, as well adaptations of the work for whatever purpose. However, in some contemporary cases, such rights could either be jointly shared by both the creators of the work and the producers or marketers of the work; or completely ceded out to the producers / marketers in exchange for compensation in the forms of sales percentages, or payment of royalties [41].

Economic rights could also be granted as related rights to copyrights, "beginning with the creation and fixation of the work, and lasting for not less than 50 years after the creator's death." However, some jurisdictional laws could further extend this duration; all allowing sufficient time for heirs and successors reap financial gains from the copyright. Related morals rights allow individuals the right to claim authorship of a work or oppose adjustments / adaptations of the work that could mar the reputation of the original creator. Copyrights and related rights could be pursued and

enforced using civil litigation, criminal prosecution, administrative resolutions / remedies, amongst others [41].

Within the academic circle, one of the most popular breaches of copyrights is related to Plagiarism. Plagiarism is simply the attribution of the thoughts, ideas, expressions and language of an individual as belonging to oneself or belonging to someone else. This is a breach of copyright because amongst other reasons, copyrights are granted in order that owners / creators could receive due recognition or accrue economic benefits for their works, so as to encourage enhancements, more creativity and innovation [41]. By virtue of this definition of plagiarism, the offense at discussion here is not that the intellectual properties of other were used, but that it was used without credit to them as the original owners of the property or permission from them (where specified and/or required) was not duly received. In most legal jurisdictions, the penalty for violations of copyrights usually include (but not limited to) jail terms and fines / levies.

IX. SUMMARY & CONCLUSION

In summary, towards a rewarding research experience, it is exigent that the researcher bears in mind that the research process should always begin with a the development or formulation of a problem, usually from preliminary literature traverse or metaphysical unknowns; followed by an extensive literature review to discover a lacuna(e) that intersects appropriately with the problem and to understand the nature of the discourse in the problem domain; then S-M-A-R-T research objectives must be drafted and developed, before a well-structured research design would be engineered, using the most efficient research methodology; next would be the phase of data collection, project development, experimentation, etc.; after this would follow the stage of analysing the data / information obtained and then interpreting it with respect to how it leads to the problem solution; and finally, formally reporting and documenting the research and its findings in a most understandable manner for dissemination would basically conclude the research process.

Conclusively, research is a systematic activity that has the potential for fun and excitement for the researcher who understands the systematic processes and various viewpoints that should be taken into perspective when engaging in a research activity; especially within a widely diversified and complex field such as Computer Science. This research has been able to provide a progressive insight into the systematic activities that characterize the most effective and ground-breaking research activities that may be used as a first-principles reference guide / manual for the beginning researcher of Computer Science.

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Bibliography and Further Reading

- ✓ Booth, Colomb, & Williams: *The Craft of Research*, (3rd Edition); Chicago, 2003.
- ✓ Schwartz: *Step by Step Research and Writing*, 1997.
- ✓ Salmani-Nodoushan and Alavi: *APA Style and Research Report Writing*; Iran, 2004.
- ✓ Chisholm: *The Internet Guide for Writers*; United Kingdom, 2001.
- ✓ Cargill and O'connor: *Writing Scientific Research Articles – Strategy and Steps*; United Kingdom, 2009.
- ✓ Marczyk, DeMatteo, and Festinger: *Essentials of Research Design and Methodology*; New Jersey, 2005.
- ✓ Kothari: *Research Methodology – Methods and Techniques (2nd Revised Edition)*; New Delhi, 2004.

XI. REFERENCES

- [1] American Heritage®. (2011). *Dictionary of the English Language (Fifth Edition)*. Houghton Mifflin Harcourt Publishing Company. Retrieved March 20, 2016, from The Free Dictionary: <http://www.thefreedictionary.com/research>
- [2] Zacharias, R. (2008). *The End of Reason: A Response to the New Atheists*. Grand Rapids, Michigan: Zondervan.
- [3] King James Version. (2012). *The Holy Bible*. Grand Rapids, Michigan: Zondervan Bible Publishers.
- [4] Al-Azhar University. (1924). *The Holy Quran*. Cairo.
- [5] Singh, G., & Kaur, V. (2007). Formulation of a research project. *Indian Journal of Dermatol Venereol Leprol*. Retrieved January 29, 2016, from <http://www.ijdv.com/text.asp?2007/73/4/273/33649>
- [6] Leedy, P. D. (1989). *Practical Research*. New York: Macmillian Publishing Co. Int.
- [7] Baker, J. R., & Brizee, A. (2008). *Writing a Research Paper*. Retrieved from <https://owl.english.purdue.edu/>
- [8] Neville, C. (2007). *'Introduction to Research and Research Methods': Effective Learning Service*. Bradford: School of Management, University of Bradford.
- [9] Dicks, D. R. (1970). Early Greek Astronomy to Aristotle. In *Early Greek Astronomy to Aristotle* (pp. 72–198). Ithaca, N.Y.: Cornell University Press.
- [10] Pigafetta, A. (1922). Magalhães, Fernão de, d. 1521 (Magellan's Voyage around the World). In A. A. Clark, *Voyages around the world*. Madrid: Calpe.
- [11] Paul, T. W. (2009). *How to write a research proposal*. Trinity Western University, Graduate Program in Counselling Psychology. Langley, BC, Canada: Trinity Western University. Retrieved January 28, 2016, from http://www.meaning.ca/archives/archive/art_how_to_write_P_Wong.htm
- [12] Kroelinger, M. (2002, September 10). *The Research Problem*. Retrieved March 31, 2016, from Arizona State University: <http://www.public.asu.edu/~kroel/www500/The%20Research%20Problem.pdf>
- [13] Bartle, P. (2011, September 28). *SMART; Characteristics of Good Objectives*. Retrieved March 28, 2016, from CEC: Community Empowerment Collective: <http://cec.vcn.bc.ca/cmp/modules/pd-smar.htm>
- [14] Machi, L. A., & McEvoy, B. T. (2012). *The Literature Review*. London: Sage Publishers.
- [15] Keshav, S. (2007). How to Read a Paper. *ACM SIGCOMM Computer Communication Review*, 37(3), 83-84. Retrieved April 1, 2016
- [16] Sonia, M. (2010). How to Write an Effective Literature Review. In *Literature Review*. Asian Institute of Technology.
- [17] Baglione, L. (2012). *Writing a Research Paper in Political Science*. Thousand Oaks: CQ Press.
- [18] Shields, P., & Rangarjan, N. (2013). *A Playbook for Research Methods: Integrating Conceptual Frameworks and Project Management*. Stillwater, OK: New Forums Press.
- [19] Derese, S. (2012). *Introduction to PhD Research Proposal Writing*. Nairobi, Kenya: Department of Chemistry, University of Nairobi.
- [20] Nolinske, T. (1996). Writing a Research Proposal. *American Academy of Orthotists and Prosthetists*, 8(4), 132-137.
- [21] National Council for Science and Technology (NCST) & International Development Research Centre (IDRC). (1989). *Guidelines for the Formulation of Research Project Proposals*. (S. O. Keya, B. F. Makau, J. Mani, & I. M. Omari, Eds.) Nairobi, Kenya, Kenya: Oxford University Press, Eastern Africa. Retrieved April 1, 2016, from <https://idl-bnc.idrc.ca/dspace/bitstream/10625/2572/1/36721.pdf>
- [22] International Tropical Timber Organization (ITTO). (2009). *Manual for project formulation (3rd Edition)*. International Tropical Timber Organization (ITTO).
- [23] Cargill, M., & O'Connor, P. (2009). *Writing Scientific Research Articles: Strategy and Steps, 1st edition*. Blackwell Publishing.
- [24] Salmani-Nodoushan, M. A., & Alavi, S. M. (2004). *APA Style and Research Report Writing*. Iran: Zabankadeh Publications.

- [25] The University of York. (2012). *The IEEE Style (2012 Edition)*. Retrieved March 10, 2016, from The University of York: https://www.york.ac.uk/integrity/downloads/15663_III%20Style-webFINAL.pdf
- [26] Office of Research Services. (2015, May 2). *Proposal Development Resources*. Retrieved March 11, 2016, from University of Oklahoma: <http://ors.ou.edu/proposal/type.html>
- [27] Kothari, C. R. (2004). *Research Methodology: Methods and Techniques*. India: New Age International Publishers.
- [28] Kumar, R. (2005). *Research Methodology: A Step-by-Step Guide for Beginners (2nd Edition)*. Singapore: Pearson Education.
- [29] Stanovich, K. (2007). *How to Think Straight About Psychology: 8th Edition*. Boston, MA: Allyn & Bacon.
- [30] Cohen, D., & Crabtree, B. (2006, July). *Qualitative Research Guidelines Project*. Retrieved March 30, 2016, from Robert Wood Johnson Foundation: <http://www.qualres.org/HomeInte-3516.html>
- [31] Angen, M. J. (2000). Evaluating Interpretive Inquiry: Reviewing the Validity Debate and Opening the Dialogue. *Qualitative Health Research*, 10(3), 378-395.
- [32] Blumer, M. (1969). *Symbolic Interactionism*. Englewood Cliffs, NJ: Prentice-Hall.
- [33] Andy, S. (2012). Inductive or Deductive? Two Different Approaches. Retrieved March 10, 2016, from 2012books.lardbucket.org/books
- [34] Oates, B. J. (2009). *Researching Information Systems and Computing*. London: SAGE Publishers.
- [35] Sembok, T. M. (November 2003). Ethics of Information Communication Technology (ICT). *Proceedings of the Regional Meeting on Ethics of Science and Technology* (pp. 239-325). Bangkok: UNESCO: Regional Unit for Social & Human Sciences in Asia and the Pacific (RUSHSAP).
- [36] Laudon, K. C. (1995, December). Ethical concepts and information technology. *Communications of the ACM*, 38(12), 33-39. doi:10.1145/219663.219677
- [37] European University Institute. (2013). *Code of Ethics in Academic Research (2013 Edition)*. Italy: European University Press. Retrieved from <http://www.eui.eu/Documents/ServicesAdmin/DeanOfStudies/CodeofEthicsinAcademicResearch.pdf>
- [38] Borow, R. H. (March 14, 1986). *Don't Dump Nuclear Junk in Maine Lakes*. Pasadena, California, USA.: The New York Times.
- [39] Guidoboni, T. A., & Meltzer, E. R. (1991). *United States v. Morris*, 928 F. 2d 504. United States Department of Justice . Washington, D.C.: US Court of Appeals. Retrieved April 26, 2015, from http://scholar.google.com/scholar_case?case=551386241451639668
- [40] Westby, J. R. (2013). *Legal Guide to Botnet Research*. Illinois: American Bar Association (ABA) Publishing.
- [41] WIPO. (2011). *What Is Intellectual Property*. World Intellectual Property Organization (WIPO). Geneva: WIPO Press. Retrieved February 21, 2016, from http://www.wipo.int/edocs/pubdocs/en/intproperty/450/wipo_pub_450.pdf