RESEARCH METHODOLOGY & INNTELECTUAL PROPERTY RIGHTS – 21RMI56

MODULE 2

Literature Review and Technical Reading: New and Existing Knowledge, Analysis and Synthesis of Prior Art, Bibliographic Databases, Web of Science, Google and Google Scholar, Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet. **Attributions and Citations:** Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.

Introduction

The primary goal of literature review is:

- To know the use of content/ideas/approaches in the literature to correctly identify the problem.
- To advocate a specific approach adopted to understanding the problem, and to access the choice of methods used.
- It also helps the researcher understand clearly that the research to be undertaken would contribute something new and innovative.
- The quality of such review can be determined by evaluating if it includes appropriate breadth and depth of the area under study, clarity, rigor, consistency, effective analysis.

New and Existing Knowledge

New knowledge in research can only be interpreted within the context of what is already known, & cannot exist without the foundation of existing knowledge. The new knowledge can have vastly different interpretations depending on what the researcher's background, and one's perception of that new knowledge can change from indifference to excitement (or vice versa). The existing knowledge is needed to make the case that there is a problem and that it is important.

One can infer that the knowledge that is sought to be produced does not yet exist by describing what other knowledge already exists and by pointing out that this part is missing so that what we have is original. To do this, one again needs the existing knowledge: the context, the significance, the originality, and the tools.

Where does this existing knowledge come from?

- By reading and surveying the literature in the field that was established long ago and also about the more recent knowledge which is in fact always changing.
- The textbooks contain the older established knowledge and the research papers the newer work.
- Reading the textbooks provide the established knowledge and the background to be able to read the newer work usually recorded in the research papers.
- The research paper is written for other researchers out on the edge of knowledge and it assumes that the reader already knows a lot in that field.
- The objective with all this reading and learning is to be able to get the knowledge that one needs to build the foundation.

The review process must explain how a research item builds on another one. An effective review of literature ensures a firm foundation for advancing knowledge, facilitates theoretical growth, eliminates as areas that might be of interest, and opens new avenues of possible work. An efficient literature review is centered on concepts and not authors.

Generally, a good literature survey is the first expectation of a supervisor from the research student, and when done well can create a good impression that the state of art in the chosen field is well understood. A good literature review would not draw hasty conclusions and look into the individual references to determine the underlying causes /assumptions /mechanisms in each of them so as to synthesize the available information in a much more meaningful way.

A literature review should be able to summarize as to what is already known from the state of the art, detail the key concepts and the main factors or parameters and the underlying relationships between those, describe any complementary existing approaches, enumerate the inconsistencies or shortcomings in the published work, identify the reported results that are inconclusive or contradictory, and provide a compulsive reason to do further work in the field.

A good literature survey is typically a two-step process as enumerated below:

(i) Identify the major topics or subtopics or concepts relevant to the subject under consideration.

(ii) Place the citation of the relevant source article/patent/website/data, etc. in the correct category of the concept/topic/subtopic.

A comprehensive literature survey should methodically analyze and synthesize quality archived work, provide a firm foundation to a topic of interest and the choice of suitable research methodologies, and demonstrate that the proposed work would make a novel contribution to the overall field of research.

Analysis and Synthesis of Prior Art

After collecting the sources, usually articles, intended to be used in the literature review, the researcher is ready to break down each article and identify the useful content in it, and then synthesize the collection of articles. A literature survey grid of *N* topics and *M* sources help to crystallize the information in different categories.

A researcher should analyze the relevant information ascertained in Table 2.1 by undertaking below steps:

i. Understanding the hypothesis,
ii. Understanding the models & the experimental conditions used,
iii. Making connections,
iv. Comparing and contrasting the various information, and
v. Finding out the strong points and the loopholes.

Table 2.1: Literature survey grid

	Source 1	Source 2	...	Source M
Topic 1		✓		
Topic 2	✓			✓
⋮				
⋮				
Topic N	✓	✓		

The goal of literature survey is to bring out something new to work on through the identification of unsolved issues, determine the problems in the existing models or experimental designs, and present a novel idea and recommendations. No matter where one gets the available information, one needs to critically evaluate each resource that the researcher wishes to cite.

Few criteria's that help the researcher in the evaluation of the information under study are:

Authority: What are the author's credentials and affiliation? Who publishes the information?

Accuracy: Based on what one already knows about the topic or from reading other sources, does the information seem credible? Does the author cite other sources in a reference list or bibliography, to support the information presented?

Scope: Is the source at an appropriate comprehension or research level?

Bibliographic databases

"Bibliographic databases" refer to "abstracting and indexing services" useful for collecting citation-related information and possibly abstracts of research articles from scholarly literature and making them available through search. Few of the popular bibliographic databases most sought after by engineering researchers are:

Web of Science: Web of Science (formerly known as ISI or Thomson Reuters) includes multiple databases, as well as specialized tools. It is a good search tool for scholarly materials requiring institutional license. It allows the researcher to search in a particular topic of interest, which can be made by selection in fields that are available in drop down menu such as title, topic, author, address, etc. The tool also allows sorting by number of citations (highest to lowest), publication date.

Effective searching in Web of Science: Put quotes around phrases, add more keywords, or use the "Refine Results" panel on the left to narrow down the search by keyword, phrases in quotation marks, type of material such as peer-reviewed journal articles, date, language, and more. Expanding the search results is possible by looking for alternate word endings, breaking the search concepts down, thinking of alternate search terms (including scientific names if applicable) and connecting them with OR, and using the database's features for finding additional references. "Cited reference search" option enables a researcher to trace articles which have cited a formerly published paper. Using this element, it is possible to find how a familiar idea has been applied, improved, or extended subsequently.

Google and Google Scholar

Google is a great place to start one's search when one is starting out on a topic. It can be helpful in finding freely available information, such as reports from governments, organizations, companies, and so on. However, there are limitations:

i. It's a "black box" of information. It searches everything on the Internet, with no quality control—one does not know where results are coming from.
ii. There are limited search functionality and refinement options.

Google Scholar limits one's search to scholarly literature. However, there are limitations:

i. Some of the results are not actually scholarly. An article may look scholarly at first glance, but is not a good source upon further inspection.
ii. There is limited search functionality and refinement options.

iii. It is not comprehensive. Some publishers do not make their content available to Google Scholar.

Search operators are available that can be used to help narrow down the results. These help one find more relevant and useful sources of information. Operators can be combined within searches. Here are some basic ones that one can use:

i. **OR** - Broadens search by capturing synonyms or variant spellings of a concept. Example: Synchronous OR asynchronous will find results that have either term present.

ii. **Brackets/Parentheses ( )** - Gather OR'd synonyms of a concept together, while combining them with another concept. Example: RAM (synchronous OR asynchronous).

iii. **Quotation marks " "** - Narrow the search by finding words together as a phrase, instead of separately. Example: RAM (synchronous OR asynchronous) "Texas Instruments".

iv. **Site** - limits the search to results from a specific domain or website. This operator is helpful when searching specific websites such as the BC government, which is Example: RAM (synchronous OR asynchronous) "Texas Instruments" site: http://ieeexplore.ieee.org.

v. **Filetype** - limits the search to results with a specific file extension one could look for pdf's, PowerPoint presentations, Excel spreadsheets, and so on. Example: RAM (synchronous OR asynchronous) "Texas Instruments" site: http:// ieeexplore.ieee.org, filetype: pdf.

The Search Tools button at the top of the Google results gives you a variety of other options, such as limiting the results by date. There are other operators and tools that one can use in Google and Google Scholar.

Effective Search: The Way Forward

While most of the engineering researchers need to refer articles that appear in scholarly journals, books or other peer-reviewed sources, there is also a substantially useful content in more popular publications.

A researcher should use all search tools for comprehensive search. No one place or one source exists that will provide all the information one needs. A researcher must consider what type of information is needed, and where it could be

found. Not all information is available online. Some information is only available in print. It can take time for scholarly and peer-reviewed information to be published. Searching is an iterative process:

- Experiment with different keywords and operators;
- Evaluate and assess results, use filters;
- Modify the search as needed; and
- When relevant articles are found, look at their citations and references.

After the search is complete, the researcher needs to engage in critical and thorough reading, making observation of the salient points in those sources, and summarize the findings. A detailed comparison and contrast of the findings is also required to be done. This entire process may be needed to be done multiple times.

The conclusion of the entire process of literature survey includes a summary of the relevant and important work done, and also the identification of the missing links and the challenges in the open problems in the area under study. The literature survey is a continuous and cyclical process that may involve the researcher going back and forth till the end of the research project.

It is mandatory for a Ph.D. scholar to write a synopsis of the topic and submit it to the doctoral committee for approval. During this stage, the scholar needs to undertake an extensive literature survey connected with the problem. For this purpose, the archived journals and published or unpublished bibliographies are the first place to check out. One source leads to another.

Introduction to Technical Reading

It is also important to know where to read from; relying on refereed journals and books published by reputed publishers is always better than relying on easily available random articles off the web.

Strategies for Reading Research Papers:

1. Selective Reading: Not all papers are worth reading in-depth. An initial skimming helps decide whether a paper is worth further exploration.

2. Skimming Process:

a. Read the title and keywords: Determine if the paper is interesting and relevant. If it doesn't seems to be relevant, stop reading and look for something else to read.

b. Read the abstract: To get an overview of paper's content & relevance in minimum time. If the abstract is of interest, then skip most of the paper and

c. Jump to conclusions: Find if the paper is relevant to the intended purpose, and if so, then read the figures, tables, and the captions therein,

3. If the paper has continued to be of interest so far, then do in depth reading:

a. Introduction section: To know the background information about the work and also to ascertain why the authors did that particular study and in what ways the paper furthers the state of the art.

b. Results and Discussion section (Experimental Setup/Modelling): To understand exactly what was done to better understand the meaning of the data and its interpretation.

4. Consider Author Reputation: Evaluate not only the content but also the reputation of the authors who produced the knowledge.

5. Staying Updated: Continuously search for relevant literature and remain up-to-date with developments in the field.

Conceptualizing Research

Research objectives must centre on new knowledge and gain recognition from the research community. While originality and significance are key, a solvable approach is crucial. Conceptualizing research involves aligning a significant problem, necessary knowledge, and applicable methods, which requires expertise in the field.

Characteristics of a Good Research Objective:

1. Novelty and Significance: Research objectives should contribute new insights and be recognized as valuable by peers.

2. Feasibility: Objectives should be achievable within available resources and methodologies.

Conceptualizing Research at Different Levels:

1. Ph.D. Level and Higher:

a. Expertise Requirement: Developing a research objective demands expertise at the edge of knowledge.

b. Immersion in Literature: Continuously reading and understanding existing literature is crucial for combining problem significance, existing knowledge, and potential methods.

2. Smaller Scope Projects (Master's Thesis):

a. Expert Guidance: Researcher may lack the time to become an expert. Supervisor's expertise helps formulate research objectives.

b. Efficient Literature Navigation: Established researchers guide towards essential literature for a focused understanding.

Balancing Building and Knowledge Creation:

• Engineer's Perspective: Engineers often prefer tangible outcomes. However, research's primary goal is new knowledge creation.

• Building vs. Knowledge: Even unique creations can be labelled as lacking research value if they are intuitive and expected from competent engineers.

Effective research objectives require a deep understanding of the problem's significance, relevant knowledge, and applicable methodologies. Developing such objectives demands immersion in existing literature and becoming an expert at the edge of knowledge. While larger research projects demand individual expertise, smaller projects benefit from expert guidance. Balancing tangible outcomes with knowledge creation is essential to ensure the research's true value is realized and recognized.

Critical and Creative Reading

Reading a research paper is a critical process. The reader should not be under the assumption that reported results or arguments are correct. Rather, being suspicious and asking appropriate questions is in fact a good thing.

- Have the authors attempted to solve the right problem?
- Are there simpler solutions that have not been considered?
- What are the limitations (both stated and ignored) of the solution and are there any missing links?
- Are the assumptions that were made reasonable?
- Is there a logical flow to the paper or is there a flaw in the reasoning?

These need to be ascertained apart from the relevance and the importance of the work, by careful reading.

Use of judgemental approach and boldness to make judgments is needed while reading. Flexibility to discard previous erroneous judgments is also critical. Additionally, it is important to ascertain whether the data presented in the paper is right data to substantiate the argument that was made in the paper and whether the data was gathered and interpreted in a correct manner.

Creative reading requires a positive approach in search. In creative reading, the idea is to actively look for other applications, interesting generalizations, or

extended work which the authors might have missed? Are there plausible modifications that may throw up important practical challenges? One might be able to decipher properly if one would like to start researching an extended part of this work, and what should be the immediate next aspect to focus upon.

Challenges in Critical and Creative Reading:

• Critical vs. Creative: Critical reading aims to identify errors, while creative reading involves seeking new opportunities and insights.

• Relative Difficulty: Creative reading can be more challenging than critical reading, requiring a proactive and open-minded approach.

Taking Notes While Reading

Strong reading skills are fundamental for effective research writing. The transition from reading to writing is facilitated by the practice of taking notes during and after the reading process. Note-taking helps researchers remember and utilize valuable information, ensuring a smoother transition from reading to writing.

The bridge between reading and actually writing a paper is the act of taking notes during and shortly after the process of reading. There is a well-known saying that the faintest writing is better than the best memory, and it applies to researchers who need to read and build on that knowledge to write building on the notes taken.

Many researchers take notes on the margins of their copies of papers or even digitally on an article aggregator tool. In each research paper, there are a lot of things that one might like to highlight for later use such as definitions, explanations, and concepts. If there are questions of criticisms, these need to be written down so as to avoid being forgotten later on. Such efforts pay significantly when one has to go back and reread the same content after a long time.

On completing a thorough reading, a good technical reading should end with a summary of the paper in a few sentences describing the contributions.

Reading Mathematics and Algorithms

Mathematics is often the foundation of new advances, for evolution and development of engineering research and practice. An engineering researcher generally cannot avoid mathematical derivations or proofs as part of research work. Researcher should avoid skimming them. By meticulous reading of the proofs or algorithms, after having identified the relevance of the paper, one can develop sound understanding about the problem that the authors have attempted to solve.

One might skim a technical section for various reasons. But, implementation of an intricate algorithm in programming languages such as C, C++ or Java is prone to errors. And even if the researcher is confident about the paper in hand, and thinks that the algorithm will work, there is a fair chance that it will not work at all. So one may wish to code it quickly to check if it actually works.

Reading a Datasheet

In various engineering fields, researchers encounter diverse types of documents that are crucial for understanding, designing, and incorporating specific components or parts. Researchers in the field of electronics need to read datasheets. Datasheets in electronics, serve as instruction manuals for electronic components and play a pivotal role in circuit design, debugging, and integration.

Reading Datasheets (contents):

- Functional Block Diagram: The first page of the datasheet usually summarizes a part's function and features, basic specifications, and usually provides a functional block diagram with the internal functions of the part.
- Pinout: A pinout provides the physical location of a part's pins, with special mark for pin 1 so that the part can be correctly plugged into the circuit.
- Graphs and Performance: Provides graphs showing performance versus various criteria (supply voltage, temperature, etc.), and safe region for reliable operation which should be carefully read and noted by the researcher.
- Truth table: Describes what sort of inputs provide what types of outputs.
- Timing diagrams: Lays out how and at what speed data is sent and received from the part.
- Package Dimensions: Datasheets usually end with accurate dimensions of the packages. This is useful for printed circuit board (PCB) layout.

Datasheets serve as indispensable resources for electronic component information, aiding researchers in circuit design, debugging, and integration. Properly reading and comprehending datasheets allow researchers to make informed decisions, optimize circuit performance, and enhance overall efficiency. The skill of reading technical documents extends beyond datasheets, encompassing a range of specialized documents in different engineering fields.

Attributions and Citations: Giving Credit Wherever Due

Academic writing, by definition, must follow certain rules and conventions. Among the most important of these are the rules and conventions about citing, referencing, attributing, and acknowledging the works of others. That means giving proper credit wherever due. Citing is the practice of quoting from, referring to other authors' works and ideas in the text of our work in such a way that the context is clear to the reader. Referencing is the listing of the full publication details of a published work that is cited so as to give background information to the readers.

Acknowledgment in research publications indicates contributions to scientific work. Acknowledgment is arguably more personal, singular, and simply an expression of appreciations and contribution.

Citations: Functions and Attributes

Citations (references) credit others for their work, while allowing the readers to trace the source publication if needed. Any portion of someone else's work or ideas in papers, patents, or presentations must be used in any new document only by clearly citing the source. This applies to all forms of written sources in the form of texts, images, sounds, etc. and failure to do may be considered plagiarism. Depending on the exact type of material, the researcher may need to give due credit to the creator of the original source.

When a bibliography of previously published patents or papers is placed in the new works of a researcher, a connection is established between new and previous work. The researcher provides due credit through the use of a citation. Citations help the readers to verify the quality and importance of the new work and justification of the findings. It is a way to tell readers that certain material in the researcher's present work has come from another source and appropriate credit has been given to the original author or writer. Materials that can be cited include journal papers, conference proceeding, books, theses, newspaper articles, websites, etc. Citations should be given at the end of a sentence or the end of a paragraph.

A researcher needs to cite each source twice:

(i) in-text citation, in the text of the article exactly where the source is quoted or paraphrased, and

(ii) a second time in the references, typically at the end of the chapter or a book or at the end of a research article.

There are three main functions of citation:

(i) Verification function: Authors have a scope for finding intentional or unintentional distortion of research or misleading statements. Citation offers the readers a chance to ascertain if the original source is justified or not, and if that assertion is properly described in the present work.

(ii) Acknowledgment function: Researchers primarily receive credit for their work through citations. Citations play crucial role in promotion of individual researchers. Many reputed organizations and institutes provide research funding based on the reputations of the researchers. Citations help all researchers to enhance their reputation and provide detailed background of the research work.

(iii) Documentation function: Citations are also used to document scientific concepts and historical progress of any particular technology over the years.

There are certain cases when references do not fulfill the actual goal of citations and acknowledgments, & thus do not benefit the reader.

1. Spurious citations: In certain cases, when citation is not required or an appropriate one is not found, if the author still includes one, it would be considered as a spurious citation. These sorts of citations do not add any value to the reader in terms of properly understanding the paper. Such actions result in loss of time of the reader or reviewer in looking for the cited paper. Inappropriate credit must be avoided so that the credibility of a research work is not lost through this sort of carelessness.

2. Biased citations: When authors cite the work of their friends or colleagues despite there being no significant connection between the two works, or when they do not cite work of genuine significance because they do not wish to give credit in the form of citation to certain individuals, then such actions can be classified as biased citations.

3. Self-citations: Self-citation of prior papers is natural because the latest paper is often a part of a larger research project which is ongoing. It is advantageous for the reader because citations of all the related works of the same author are given in one paper and will reduce the effort of the reader to find the full versions of those papers.

4. Coercive citations: Despite shortcomings, impact factors remain a primary method of quantification of research. One side effect is that it creates an incentive for editors to indulge in coercion to add citations to the editor's journal.

Impact of Title and Keywords on Citations

The citation rate of any research paper depends on various factors including significance and availability of the journal, publication types, research area, and importance of the published research work. Other factors like length of the title, type of the title, and selected keywords also impact the citation count.

Title is the most important attribute of any research paper. It is the main indication of the research area or subject and is used by researcher as a source of information during literature survey. Title plays important role in marketing and makes research papers traceable. A good title is informative, represents a paper effectively to readers, and gains their attention.

Some titles are informative but do not capture attention of readers, some titles are attractive but not informative or related to the readers research area. Download count & citation of research paper might be influenced by title. Three different aspects which provide a particular behavior to the title are:

i. types of the title,
ii. length of the title, and
iii. presence of specific markers

The titles containing a question mark, colon, and reference to a specific geographical region are associated with lower citation rates. Result-describing titles usually get citations than method-describing titles. Review articles and original articles usually receive more citations than short communication articles. At least two keywords in the title can increase the chance of finding and reading the article as well as get more citations.

Keywords represent essential information as well as main content of the article, which are relevant to the area of research. Search engines, journal, digital libraries, and indexing services use keywords for categorization of the research topic and to direct the work to the relevant audience. Keywords are important to ensure that readers are aware about research articles and their content.

If maximum number of allowable keywords are used, then the chance of the article being found increases and so does the probability of citation count of the article. Usage of new keywords should be minimal as such keywords may not be well known to the research community and so may lead to low visibility of the article.

Knowledge Flow through Citation

Knowledge flows through verbal communications, books, documents, video, audio, and images. In engineering research, knowledge flow is primarily in the form of books, thesis, articles, patents, and reports. Citing a source is important for transmission of knowledge from previous work to an innovation. Production of knowledge can be related to the citation network.

Knowledge flow happens between co-authors during research collaboration, among other researchers through their paper citation network, and also between institutions, departments, research fields or topics, and elements of research. Figure 2.1 shows the relationship between citations, knowledge flow, and elements such as researchers, papers, journal publications or conferences, and institutions. If paper A is cited by paper B, then knowledge flows through citation networks across institutions. The complex interdisciplinary nature of research encourages scholars to cooperate with each other to grab more advantages through collaboration, thereby improving quality of the research.

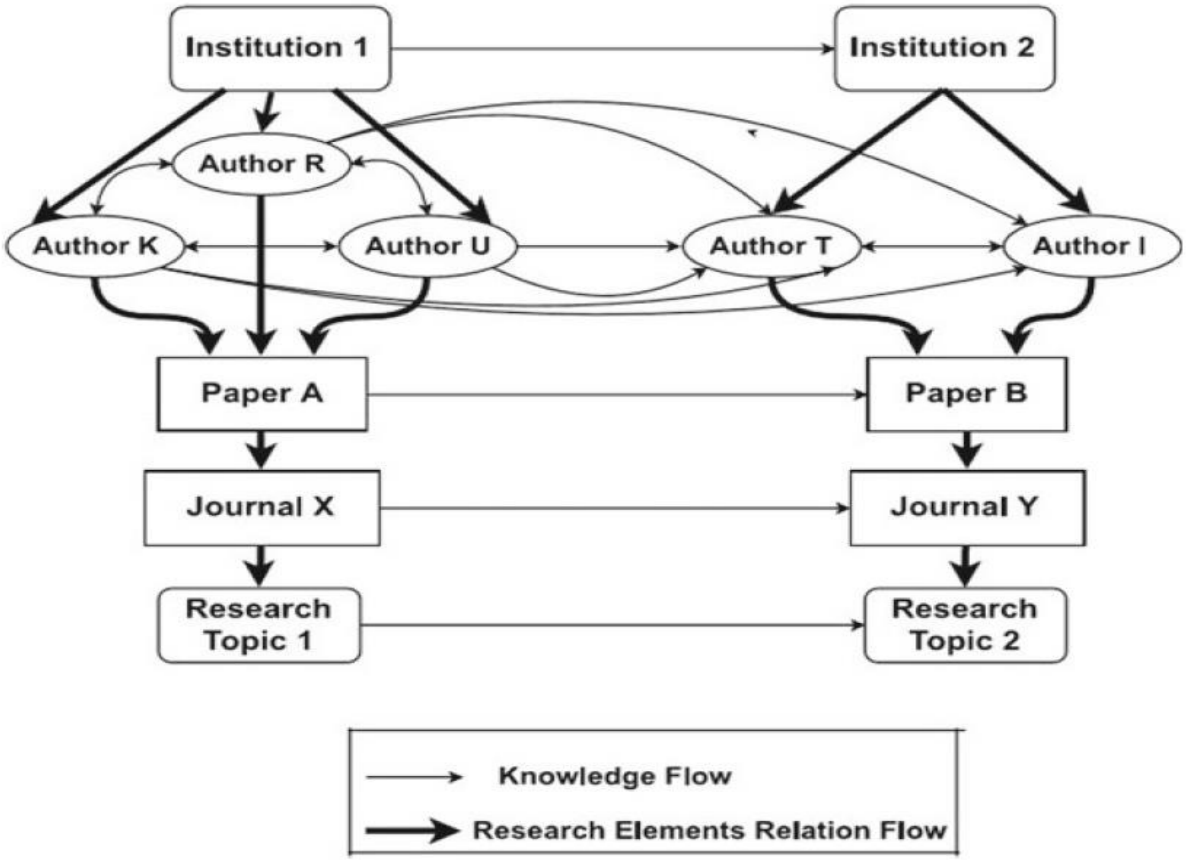

Fig. 2.1: Citation-based knowledge flow

Figure 3.2 shows a relationship between co-authorship and different types of citations. Three articles (X, Y, and Z) and five references (X1, X2, X3, Y1, and Y2) of article X and Y, respectively, are considered. A, B, and C are authors of article X, and D, E, F, G, and also A are authors of article Y. Article Z has two authors H and E. References X1, X2, X3, Y1, and Y2 have authors (A, P), (H, R), (D), (Q, B, F), and (R), respectively.

Based on co-authorship citation network, references X1 and Y1 are considered self-citation, reference X3 is a level-1 co-author citation because author of article is direct collaborator of author A, reference X2 is a level-1 co-author network because author A is collaborator of E who collaborated with H.

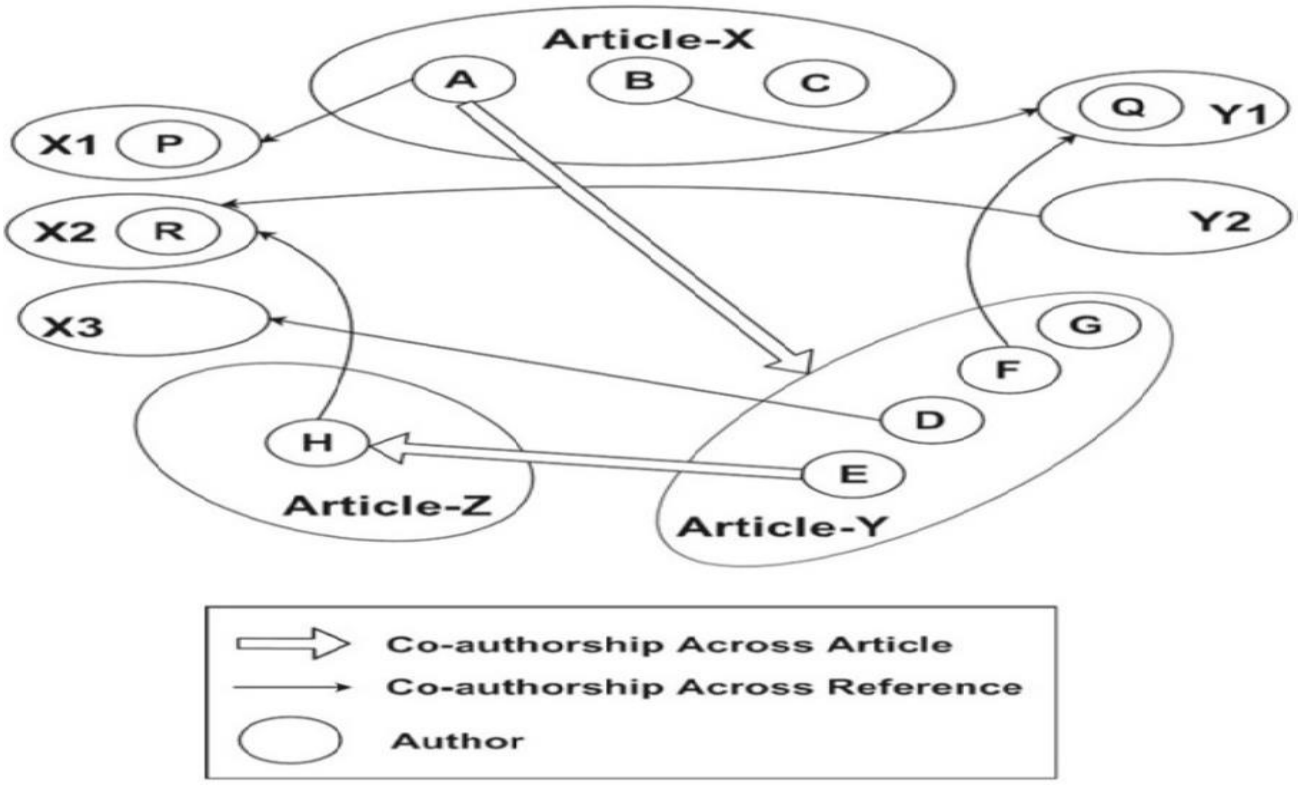

Fig. 3.2: Co-authorship Network

Styles for Citations

Citation styles differ primarily in the order, and syntax of information about references, depending on difference in priorities attributed to concision, readability, dates, authors, and publications. Some of the most common styles for citation (as well as other aspects of technical writing) used by engineers are as follows:

1. ASCE style (American Society of Civil Engineers)

(a) Reference list: This part is to be placed in the bibliography or references at the end of the article or report. A template with example for the same is given below:

Template for books: Author Surname, Author Initial. (Year Published). Title. Publisher, City, Pages Used. Example: Wearstler, K., and Bogart, J. (2004). Modern glamour. Regan Books, NY, 142–160.

Template for websites: Author Credentials / Company Name (Year Published). 'Title'. http://Website URL (Oct. 10, 2013). Example: Blade cleaning services (2015): http:// www.bladecleaning.com/problematica (29 Oct, 2016).

Template for journal publications: Author Surname, Author Initial. (Year Published). 'Title'. Publication Title, Volume number (Issue number), Pages Used. Example: Johnston, L. (2014). "How an Inconvenient Truth Expanded The Climate Change Dialogue Reignited An Ethical Purpose in The United States". 1–160.

(b) In-text citation for journals or books: The following part is to be placed right after the reference to the source of the citation assignment:

Template: (Author Surname/Website URL Year Published)

Examples: i. Citation is a very important part of technical writing. (Deb 2016)

ii. Engineers create devices to monitor mountains so that nearby inhabitants can be warned of impending eruptions. (Teachengineering.org 2014)

2. IEEE style (Institute of Electrical and Electronics Engineers)

IEEE style is standard for all IEEE journals and magazines, and is frequently used for papers and articles in the fields of electrical engineering and computer science. The IEEE style requires endnotes and that references be cited numerically in the text. Those submitting to an IEEE publication should see guidelines for the specific journal or magazine and may also refer to the complete IEEE editorial style manual.

Examples: Chapter in an edited book:

[1]A. Rezi and M. Allam, "Techniques in array processing by means of transformations in Control and Dynamic Systems", Vol. 69, Multidimensional Systems, C. T. Leondes, Ed. San Diego: Academic Press, 1995, pp. 133–180.

3. ASME style (The Association of Mechanical Engineers)

Acknowledgments and Attributions

Acknowledgment section is a place to provide a brief appreciation of the contribution of someone or an organization or funding body to the present work. If no particular guideline is available for the intended publication, then it can be introduced at the end of the text or as a footnote. Acknowledgment is a common practice to recognize persons or agencies for being responsible in some form or other for completion of a

publishable research outcome. Acknowledgment displays a relationship among people, agencies, institutions, and research. In some case, certain individuals may help in the research work but may not deserve to be included as authors. As a sign of gratitude, such contributions should be acknowledged. Classification of acknowledgment into six different categories: moral, financial, editorial, institutional, technical, and conceptual support.

Acknowledgments and attributions are also very important in the publications of journal or conference papers. Giving proper credit wherever it is due is very important and even if the contribution is minor, it should not be neglected. A researcher should always recognize the proprietary interest of others. Whenever possible, author shall give name of persons who may be responsible, even if nominally, for designs, inventions, writings, or other accomplishments.

In engineering research, acknowledgments are meant for participating technicians, students, funding agency, grant number, institution, or anyone who provide scientific inputs, shared unpublished results, provided equipment, or participated in discussions.

What Should Be Acknowledged?

Every author should know that what should/should not be acknowledged. Author should acknowledge quotation, ideas, facts, paraphrasing, funding organization, oral discussion or support, laboratory, and computer work.

(i) Quotation: In technical writing such as in the field of engineering, quotes are used very rarely. Quotations are of two types:

(a) Direct quotations: Used when author use actual words or sentences in the same order as the original one. Author should use quotation marks for the words or sentences with proper acknowledgment.

(b) Indirect quotation: Summarizes or paraphrases the actual quote. In such cases, it is important to acknowledge with proper name and date.

(ii) Authors should acknowledge people who give appropriate contribution in their research work. Non-research work contributions are not generally acknowledged in a scientific paper but it may be in a thesis. Persons must be acknowledged by authors, who gave a scientific or technical guidance, take part in some discussions, or shared information to author. Authors should acknowledge assistants, students, or technicians, who helped experimentally & theoretically during the research work.

(iii) If the researcher received grant from a funding agency and if those funds were used in the work reported in the publication, then such support should always be acknowledged by providing full details of the funding program and grant number in the acknowledgment section.

The authors should also gratefully acknowledge use of the services and facilities of any center or organization with which they are not formally affiliated to. An example of acknowledgment of grant received is:

Acknowledgment: This research work was funded in part by the Extra Mural Research Funding 2014–17 (Individual Centric) of the Department of Science and Technology (DST), Govt. of India.

(iv) Acknowledging that results have been presented elsewhere: If the results were presented as an abstract in a journal, then there should be a suitable citation. If the results were presented as part of scientific meeting, symposium, or other gathering, then some relevant information should be provided. At the very least, the name of the gathering and year should be cited. Other helpful items include the location of the gathering (city and state or country) and the full date of the occasion.

By acknowledging all help received in one's research work, the author(s) demonstrate integrity as a researcher, which in turn encourages continued collaboration from those who helped out in different ways.

Acknowledgments in Books/ Dissertations

A page of acknowledgments is usually included at the beginning of a thesis/ dissertation immediately following the table of contents. These acknowledgments are longer than the one or two sentence statements in journal papers or articles in conference proceedings. These detailed acknowledgments enable the researcher to thank all those who have contributed in completion of the research work. Careful thought needs to be given concerning those whose inputs are to be acknowledged and in what order.

Generally, one should express appreciation in a concise manner and avoid emotive language. The following are often acknowledged in these types of acknowledgments: main supervisor, second supervisor, peers in the lab, other academic staff in the department, technical or support staff in the department, colleagues from other departments, other institutions, or organizations, former students, family, and friends.

Sample Acknowledgement in Thesis:

I wish to express my sincere appreciation to my supervisor Prof. _____ for the useful comments, remarks and encouragement throughout this thesis work. Furthermore, I wish to express my thanks to Prof. _____ for introducing me to the topic and for the support along the way. Also, I like to thank my peers in the Advanced Semiconductor Lab such as _____ and _____, who have shared their precious time during many lively technical discussions. I would like to thank my family members who have supported me throughout this journey in many different ways.

Dedication or Acknowledgments?

Dedication is almost never used in a journal paper, an article in a conference proceedings, or a patent, and it is used exclusively in larger documents like books, thesis, or dissertations.

While **acknowledgments** are reserved for those who helped out with the book in some way or another (editing, moral support, etc.), a **dedication** is to whomever the author would like it to be dedicated to, whether it is the author's mother, the best friend, the son/daughter, or Almighty God. It is possible to dedicate something to someone while also mentioning them in the acknowledgments. For example, one may dedicate a book to one's spouse, but acknowledge them for being the moral support and putting up with when one got much stressed.

The acknowledgments in technical books can be sometimes as brief as the ones in journal articles. The acknowledgment section of a technical report may be a paragraph that is longer than a journal paper but shorter than dissertations. Generally, the length of the acknowledgment may have some correlation with the length of the document.