How to Write a Research Paper: A Template-Based Approach

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Abstract—**The abstract is an overview of the entire project, so it covers everything from the reason for doing the project to the results we have obtained and what those results tell us. Typically the following sentences make a good structured abstract:**

- **The first sentence(s) presents an overview of main objective of the project.**
- **The next sentence(s) situates the project in terms of where the research fits with the overall discipline of study, for example we might say "*The project sits in the area of Natural Language Processing within the field of Artificial Intelligence*".**
- **Next we cover the specific research problem that we are tackling in the project, in other words, what is the specific research question being explored? We might mention the research paradigm we are using.**
- **Next we outline a few of the challenges or roadblocks that make the research question an exciting and challenging piece of research.**
- **Following that we articulate the specific approach that we are taking in this project, mentioning any relevant implementation details.**
- **Lastly, we outline the results or findings of the research, and we give some context as to why these are important and exciting outcomes.**

Index Terms — **Research Papers, Research Paradigms, Research Questions, Research Challenges.**

I. INTRODUCTION

THE Introduction section in a research paper is a combination of two things: (1) a detailed overview of research, and (2) a review of some of the key relevant literature.

The overview includes restating some of the things we have already mentioned in the Abstract, so a big challenge we will have here is how to restate the same information in different words, it may help to begin with a relevant statistic or very short anecdote, for example, "*The amount of data that is stored doubles in a little over every two years* [1]" or we could say it alternatively as, "*To begin with, it is worth noting that well over 90% of the world's data has been created in the last two years* [1]". By doing this we are giving a simple introduction to the topic of the research project, as well as hinting at the idea that this research is a relevant, important, and interesting topic that is worth exploring.

Following this initial sentence, the overview continues with sentences covering the following themes:

- We need a sentence reminding the reader of the main objective of the research, and we will try to state it in a (slightly) different way than in the Abstract.
- Next we can explain why this research is important, and represents a contribution to knowledge, so we might say something like: "*This paper advances the current body of knowledge by providing novel insights into* [specific area], *offering a comprehensive analysis that addresses previously unexplored dimensions and proposes new solutions to* [specific problem]".
- The next sentence(s), which is also in the Abstract, situates the project in terms of where the research fits with the overall discipline of study. We will try to write it differently from how it is stated in the Abstract, for example we might say "*The project is focused specifically on Computer-Based Text Translation, which is in the area of Natural Language Processing, which itself is in the field of Artificial Intelligence*".
- Next we should discuss the nature of the research process that is being used in this project. We might need to look at Creswell and Creswell's 2017 book on "Research Design" [2] to help us with this sentence. It may include any combination of the following views that will be discussed more in Section 3: *Research Paradigm*, *Research Category*, *Research Type* and *Research Objectives*
- Next we might mention the scope of the project, and we could mention a few things that will not be considered as part of the research paper, as well as some of the things that will be considered
- Following that we can include a sentence that delves into the goals of the research, potentially stating these as a set of hypotheses or milestones.
- The next sentence(s) can explain the design of the project, which could include the methodology and the methods that will be used to design this research. For example, we could mention that we are using Case Study Research, Longitudinal Research, Action Research, Grounded Theory, or Ethnographic Research. We could also discuss the design of the experiment in terms of the components we need, and

how we will construct the experimental set-up. We should also outline how the design of the experiment will clearly allow us to explore the research question.

- Finally we will outline the results that we intend to collect from the project, and how we will validate (and evaluate) those results. We can also discuss the implications of the results in the broader context.

Moving onto the other main part of the Introduction section, which is to undertake a literature review of some relevant papers to this research project. The literature review process has a number of different purposes that are worth mentioning here:

- To identify key researchers in the research area and mention their works, including seminal studies.
- To present key definitions and models relevant to this research area, and how the use of those models are justified and used.
- To present some of the results from similar projects, which provides a benchmark that can be used to compare our results.
- To implicitly point out the importance of our research project, by contextualizing it with similar research which has already been published in academic journals and at conferences.

The Literature Review should have three main sections: Beginning, Middle and Ending, as follows:

- *Beginning*: This section introduces literature related to the project topic, typically it includes 2-3 definitions relevant to the topic, as well as reviewing 3-4 papers that are important papers in this field. The objective is to "set the scene" for our research by showing the breath of the topic, and where our research fits into the broad research area.
- *Middle*: This section is the heart of the review, and will be 10-15 papers, reviewing papers that are more closely related to our research topic. The reviews will present a summary of the key points of each paper, and can be grouped together by research trend, so they might not necessarily be in chronological order.
- *Ending*: This section is a summary of the content covered in the previous two sections. It can be just a sentence or two long, and the key goal of it is to say that there has been a great deal of work done in this area, but there is a gap in the work that our research will address.

I like to think of the process of reviewing literature as being made up of three stages, which we will discuss below, they are:

1. *Literature Survey*
2. *Literature Comprehension*
3. *Literature Review*

1.1. Literature Survey

The *Literature Survey* is the first stage of the process; it is the process of identifying and acquiring the research papers, textbooks, websites, theses, etc. that we will need to help us get a comprehensive overview of the research that has already been done in the area that we are investigating. A focused survey technique is recommended to ensure we "hit the ground running" and using this technique we are almost immediately in a position to implement experiments.

One of the most important steps in this process is to identify as many of the keywords as possible that are associated with our research topic, since it is possible that different research papers may use different terms to discuss the same topic. For example, the following terms are used synonymously (or near-synonymously) in research papers: "Communities of practice", "Network of practice", "Virtual community", "Virtual Ethnography", and "Virtual team". So identifying keywords is very important to ensure that we understand the breath of a research field, and the keywords shouldn't be just synonyms of the research area, but we should also identify keywords that are subordinate and superordinate to the research area. There are a range of different software tools we can use to help us in this task, including Search tools that help search for papers (like Google Scholar[1]) and Bibliometric tools that explore relationships between research papers, and can do an analysis of keywords (like VOSviewer[2]). As important as these tools are, they are no substitute for understanding the main venues that publish papers relevant to the research area of the paper, in other words, to know the top five academic journals in this area, and the top five conferences in this area. When we look at the key journals and conferences, it helps us understand the breadth of this research area, and it exposes us to the key authors and the key models that are used in our domain.

If we are searching for papers, it is best to start with a general overview by searching for the topic with no qualifiers:

🔍 "Research Topic"

But then if we want to understand the important literature in a specific area, we should look for our topic with terms that are associated with content that has literature reviews in it:

🔍 "Research Topic" Bibliography
🔍 "Research Topic" "Literature Review"
🔍 "Research Topic" "Literature Survey"
🔍 "Research Topic" "A Roadmap"

The papers we are looking for are the ones that have any of the following: useful definitions, good literature reviews, interesting methodologies, effective implementations, and informative results and discussion sections. We can record them in a notebook or using Citation management tools (like EndNote[3]) that can help us create citations and references for this collection of papers. I like to collect between 20-25 papers before I move onto the Literature Comprehension.

1.2. Literature Comprehension

The *Literature Comprehension* is the process of reading and understanding the research that we have found in the survey process. It is important to recognize that when we are starting to explore a new research topic, there will be a lot of terms and models that we won't be familiar with, but we will be reading papers that assume we already understand these things. So it's important that we are not too hard on ourselves at this point, we can't magically learn everything about a new research topic instantaneously, so we have to take things one step at a time. My experience is that the first five papers are the worst, so we should divide the papers into sub-topics (so if we have 25 papers, if we can divide them into five sub-topics with five papers each, that'd be great), and pick one group of sub-topics, and start to read one paper at a time. We may need to read the paper one line at a time, or even one word at a time, and as we are reading, we may have to Google some of the concepts we are encountering. It might be helpful to note the following things about each of those papers:

- New Terminology
- New Models/Methodologies
- Interesting Visualizations and Diagrams
- Good discussions
- Things I don't understand

The next five papers will still be complex and there will still be more new terms and models, but they will be much easier to understand than the first five, and once we have completed reading the first ten papers, we likely will have encountered the majority information we need to know to understand the other 15 papers. This is not to say that we will understand everything about any individual paper, but we will have sufficient familiarity with the key information to have a general understanding of the papers.

To help explore the relationships between the papers, it might be helpful to create a Literature Map [3] where we look at the 25 papers in the context of the key ideas and keywords that appear in those papers. Each of the key ideas or keywords could be put in a box with a listing of one or more papers underneath the keyword, and we can draw lines joining the boxes that have themes in common. This can present a nice visualization of the key ideas that we have identified in the 25 research papers.
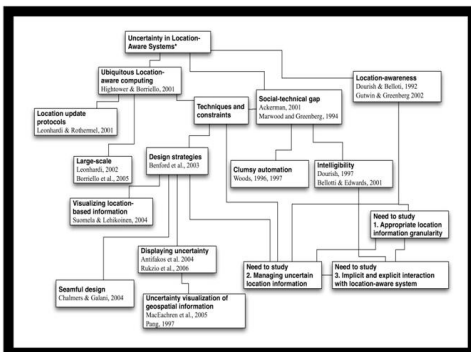

Fig. 1. A Sample Literature Map

1.3. Literature Review

The *Literature Review* is where we consolidate the various strands of past research into a single narrative describing the evolution of the research domain. What this means is that we will have to go back and re-read the papers we used in the Literature Comprehension section, but in this case we are reading them in the context of the Literature Review. To help explore the papers in detail presented in Appendix A is a checklist of questions to more fully understand the papers in terms of issues such as: how focused the research is, how useful the paper is for our research, looking at the authorship of the paper in terms of the comprehensiveness of the experimental approach (Bryn Holmes and I developed this checklist in 1999). It is worth picking at least five papers from the group of 25 papers, and reviewing those by using this checklist. This is to help us be clear as to what some of the key questions that can be reflected upon when reading research papers.

Following those reviews, the rest of the papers can be reviewed more quickly by looking at three themes in the paper, and how they relate to each other. So for each paper we should identify these three themes:

- The Research Question of that paper
- The Experiment described in the paper
- The Results of the experiment

Then we need to look at how well these three themes match each other by considering the following questions:

- Will the Experiment really address all aspects of the Research Question?
- Is it clear how the Results presented could have come from the Experiment described?
- Is the Research Question addressed effectively by the Results presented?

If all three questions can be answered with "Yes", this is likely to be a high-quality paper. The diagram below shows the three themes and their relationship with each other.
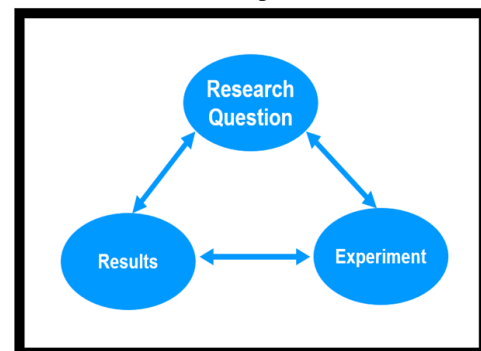

Fig. 2. Three Key Themes when reviewing a Research Paper

Writing the Literature Review can be done as a two-phase process, where the first phase looks at reviewing the papers individually, and the second phase merges those reviews together. The first phase involves presenting a summary of the paper made up of five sentences as follows:

- One sentence that explains the research question of the paper. Often this can be very similar to the paper title.
- Two sentences about the experiment, outlining the overall approach, as well as implementation details.
- Two sentences about the results, summarizing the key findings, as well as some outliers, or anomalies.

An example of this summarization technique is presented here on a fictional paper: "*Gordon (2024) explored the productivity of a large, multinational computer company. He did this by installing a software tool on all of the computers in the Sales Department, and this tool monitors all of their keyboard activity. The software tool is called KeystrokeLogger and it records all keys pushed on the keyboard, but does not record the mouse clicks (which is a limitation). The results indicate that the Sales Department of this organization is very productive, with an average rate of 18 keyclicks per minute. The results are limited as they only relate to one department in the overall organization, and the software is only measuring keyboard clicks.*"

Once all of the papers have been reviewed as above, it is time for the second phase of the process - to start merging the reviews together. So what we need to do is look at all of the reviews and identify which of them have significant overlap. So, for example, if we had another paper that was about a similar topic to the above review, but there are differences - let's imagine that in the second study the company wasn't a computer company, and it was a dog food company instead, and also the researchers used a different software tool to monitor the key clicks, and they got a rate of 15 keyclicks per minute, we could merge the two reviews together as follows: "*Both Gordon (2024) and Smith (2024) looked at productivity in two different large multinational companies. They monitored the keyclicks of one of the departments in each of the organizations using a keyboard logging tool (Gordon used KeystrokeLogger, and Smith used KeyLog7), and they found productivity rates in the range of 15-18 keyclicks per minute, and both noted the limitations of their research in terms of only looking at one department, and only logging key clicks.*"

It may be the case that the trends in the research in our domain fall into two opposing camps, the "for-and-against" type paradigm, This being the case, whichever side our work is on, we should make sure that we present the merits of each side. This gives our readers a balanced view of the domain, and gives them the impression of a researcher who can take a sophisticated perspective on matters.

In general it is better to merge reviews together where they have broadly similar methods or results, but in some cases it may not be possible to merge a lot of the reviews, it depends on the nature of the particular research area, and the type of experiment we are doing ourselves. The key thing to note about the Literature Review is that we start with the key concepts within the broader discipline and the narrow our way towards the research methods and models than most closely align with

the work that we are doing. The review does not have to be in chronological order, but instead it is better if it is in the order that most clearly shows the trends in this field.

Also, remember that writing is not necessarily a linear process, it is better if we write the sections we know about, as we learn about them. We also have to accept that there will be many drafts of the literature review, so it is best to write far too much first and then we can cut down, so we should include many of the questions for each Checklist in Appendix A in the first draft of our work and we can reduce the size of it in the subsequent drafts.

Before I start reviewing papers, I usually create two folders, one called EXPERIMENTS and one called RESULTS, and for every paper I look at, if the paper has explained their experiment very well, either textually or visually, or if they have presented their results in a very interesting or novel way, I save a copy into the appropriate folder. I usually end up with 5-10 papers per folder, and they can be really helpful later when I am writing those sections.

II. PROJECT DESIGN

If we have a Project Design section then we will use it to describe the design approach we undertook in the project, and this could include the research philosophy we have, the specific methodology we used to manage the project, and the models and methods we are using in the project. To help us focus on this section, we could look for our topic with terms that are associated with the design aspect of the project:

$\mathcal{Q}$ "Research Topic" Methodology
$\mathcal{Q}$ "Research Topic" "Research Methods"
$\mathcal{Q}$ "Research Topic" "Project Design"
$\mathcal{Q}$ "Research Topic" Models

2.1. Research Philosophy

The degree to which we specific our research approach varies from research field to research field; some fields make implicit assumptions about the type of research being undertaken whereas others prefer if the research approach is fully articulated. We will know how much of this content is required by looking at other similar papers in the domain. With this in mind we will discuss some of the common questions to reflect on to explore our approach.

Research Paradigm

The Research Paradigm is concerned with our beliefs and assumptions about research and science. The most common paradigms are presented below:

- *Positivism*: Does our experiment assume that we can obtain completely accurate results, and interpret them in a way that can lead to true findings about reality, only from observable, empirical evidence?
- *Postpositivism*: Does our experiment assume that we

can obtain results, and interpret them in a way that can lead to true findings about reality, only from observable, empirical evidence, but acknowledge that the instruments we use to measure might not be completely accurate in measuring everything and we as experimenters will have some forms of bias that might also skew the results?

- *Pragmatism*: Does our experiment assume that we can obtain results, and interpret them in a way that can lead to useful and practical information, only from observable, empirical evidence, but acknowledge that the instruments we use to measure might not be completely accurate in measuring everything and we as experimenters will have some forms of bias that might also skew the results?
- *Participatory and Advocacy*: If our research involves people, do we as researchers work with our experiment participants to formulate, design and implement our experiments. Do we also work with them to interpret the results of our experiments? If they are a minority group or a disadvantaged group, do we set out to do experiments that will help advocate for them?
- *Social Constructivism*: If our research involves individuals or groups of people, is our goal focused on getting their interpretation of events, and in understanding which social and cultural forces shaped their perception of reality for them to formulate those interpretations of events?

Research Type

The Research Type is concerned with our beliefs and assumptions about research and science. The most common paradigms are presented below:

- *Primary Research*: This is often also known as "Field Research", which means we will be collecting new data that has not been previously collected.
- *Secondary Research*: This is often also known as "Desk Research", which means we will be analyzing and interpreting data that has already been collected and published by others.

Research Objectives

The Research Objectives is concerned with our beliefs and assumptions about research and science. The most common paradigms are presented below:

- *Qualitative Research*: Are our experiments focusing on understanding human experiences, behaviours, and social phenomena through non-numerical data?
- *Quantitative Research:* Are our experiments focusing on the collection and analysis of numerical data to quantify behaviours, attitudes, or phenomena?
- *Mixed-methods Research*: Do our experiments combine both qualitative and quantitative research to provide a more comprehensive understanding of our research question?

Research Category

The Research Category is concerned with our beliefs and assumptions about research and science. The most common paradigms are presented below, and it might be the case that our experiments overlap into multiple categories, and this would be very common:

- *Theoretical Research*: Do our experiments focus on abstract reasoning, models, and simulations rather than direct measurement of real-world phenomena?
- *Empirical Research*: Do our experiments focus on direct measurement of real-world phenomena?
- *Descriptive Research*: Do our experiments focus on describing characteristics or phenomena as they naturally occur, without manipulating any variables?
- *Problem-solving Research*: Do our experiments focus on the goal of finding a solution to a specific issue or challenge?
- *Explanatory Research*: Do our experiments focus on explaining the relationships between variables and identifying causal relationships?
- *Constructive Research*: Do our experiments focus on building or creating something new, such as a model, theory, or system, and testing how well it works?

I know that this section presents a lot of information about research approaches, and it is a lot to take into account in one sitting, so don't worry if it is not all immediately obvious, you can revisit this content as you need it, and it could be the case that you only need to mention one or two of these approaches, so follow the other papers that are doing similar research for guidance.

2.2. The LASERS Model

At some point in the Design Section we should discuss themes such as the ethical, sustainable, and legal issues that may be relevant to our project; some disciplines leave it towards the end of the Design Section, but I really prefer to have it early in the section, just so that the readers can be thinking about those issues while we are discussing the models and methods in the rest of the Design Section.

To help us remember some of the key themes for this part of the Design Section, I have a model that I use for computer science papers, that might be useful, called the **LASERS** model [4], which stands for **L**egal, **A**ccessible, **S**ustainable, **E**thical, **R**eliable, and **S**ecure. Some of these considerations are:

- *Legal* – Are there any Laws, Acts, Statutes, Regulations or Rights that might be relevant to our project? For example, for computer science projects this might include ensuring compliance with industry standards and laws such as GDPR and the EU AI Act.
- *Accessible* – Do the concepts of Universal Design, Inclusiveness, or Usability apply to our project? For example, for computer science projects that means ensuring software is usable by people of all abilities, including those with disabilities.

- *Sustainable* – Have we considered all aspects of sustainability including Social, Environmental and Economic concerns? This includes trying to minimize the environmental impact, and anticipating the future impacts of our project.
- *Ethical* – Have we considered important themes such as Fairness, Accountability, Respect, and Responsibility? For computer science projects that means respecting user privacy, user autonomy, and avoiding user manipulation or exploitation.
- *Reliable* – (*this theme may be specific to Computer Science, if so, feel free to ignore if it doesn't apply to you*) Does our design consider important themes such as Availability, Scalability, Efficiency, and Maintainability? In other words, the system must still function correctly and perform adequately under various conditions.
- *Secure* - (*this theme may be specific to Computer Science, if so, feel free to ignore if it doesn't apply to you*) Does our design consider security issues including concepts such as Validation, Encryption, Auditing, and Privacy? In other words, the system must be able to safeguard the data and prevent unauthorized access, breaches, or malicious attacks.

2.3. Models and Methods

Each discipline has their own specific models and methods that they use to inform the design of experiments for that discipline. It is important to outline which ones we are using in our experiments and how exactly we are going to adhere to them. We may also want to highlight some of the strengths and weaknesses of the approach we are using and potentially it may be also worth mentioning any alternative approaches that were considered during the design process. If there is any way to represent these models and methods in a visual way (e.g. a diagram), that would be helpful for this section also. We need to give sufficient detail to ensure that other researchers can replicate our experiments, as well as potentially extending them in new directions. Some questions to reflect on when discussing the models and methods are as follows:

- Are these models and methods used by researchers thar are doing similar research to us?
- Are these models and methods going to address the stated research aims of our project?
- How can we explain the models and methods we are going to use in our project as succinctly and clearly as possible?
- Could other researchers replicate our experiments based on the details we have supplied?
- Have we identified the strengths and weaknesses of the models and methods that we are using?
- Have we clearly identified the assumptions and limitations of the models and methods?
- What alternative models and methods did we consider, and do we explain why we rejected them?

- What details have we considered in terms of the participants, materials, procedures, and data analysis techniques we will use in this research?
- Are we using a design approach that has some form of triangulation built into it (designing the gathering of data in a number of ways to ensure robustness of data collection)?
- Are the models and methods sufficiently robust to deal with unexpected (or outlying) results?

2.4. Data Collection

We may need to outline how we intend to collect data from our experiments; and in some experiments we may need to provide a lot of detail about the data collection process, whereas in other cases it may only require a sentence or two.

In the context of data collection, the first thing to consider is our target population, and what sample of that population we want to collect data about. And two important considerations that come from that are to explain how we choose our sample size, and also how we choose our sampling approach (e.g. random sampling, purposive sampling, convenience sampling, etc.), as well as our Inclusion/Exclusion Criteria [5].

We also need to explain how we are collecting the data, so what devices, sensors, software tools or surveys are we using to collect data? We should also state the level of reliability and validity of these instruments (where applicable). We should also mention any secondary data we are going to be using, and how it helps our research. We should mention the period of time over which the data will be collected, and how we will ensure that the data is systematically conducted.

In terms of how to systematically collect data, it may help to develop a detailed data collection plan (defining the dependent, independent, and control variables clearly), as well as describing the chosen methods for collecting data (surveys, observations, experiments, etc.), considering how each method aligns with our goals. If the collection process is occurring over an extended period of time, or there are multiple people involved in the collection process, it might make sense to define Standardized Operating Procedures (SOPs) for each step of data collection, ensuring each step is treated consistently [6].

We additionally need to describe the Data Analysis techniques we might use, including the models and software tools. For quantitative studies, this might include a description of which statistical tests will be used (e.g., regression analysis, t-tests), and for qualitative studies, we should describe our coding methods and/or thematic analysis. We should justify why these methods are appropriate for answering our research question. Some helpful questions to consider could include:

- Why are we collecting this data?
- What insights are we looking for?
- What are our dependent and independent variables?
- What are our control variables?
- How will the experiment collect data?
- What tools or devices are we using to collect data?

- Who will the data be collected from (if applicable)?
- What will the data be collected from (if applicable)?
- How will the sample data be collected from the population?
- How will we choose the sample size?
- How long will the data collection process take?
- How will we ensure all data is collected consistently?
- How will we try to prevent bias in the data, and bias in the data collection process?
- How will we store the data?

III. EXPERIMENT

In this section we are giving a sufficiently detailed description of what occurred during the process of actually doing the experiment, so that other researchers will be able to replicate this process. Fortunately, a lot of the information that they need to understand has been already covered in the Design Section, but in this section, we are outlining what changes had to be made when conducting the experiment due to practical constraints and unexpected challenges. If we want to see how other researchers have written a similar section we can search for terms as follows:

🔍 "Research Topic" Experiment
🔍 "Research Topic" Development
🔍 "Research Topic" Investigation
🔍 "Research Topic" Implementation

As mentioned previously, I have an EXPERIMENTS folder of 5-10 papers that presented their experiments very well, either textually or visually, and it can be very helpful to review those papers as I am writing this section of the paper.

3.1. Experimental Overview

The overview of the experiment first reminds the reader of the research question, then summarizes the design of the experiment, highlighting what is being tested and how. Some helpful questions to consider include:
- What is the research question?
- What was the experimental approach taken?
- What were the variables of interest?
- Who were the participants (where applicable)?
- What data was collected and how?
- How long did the experiment last?
- Can we create a simple diagram to represent an overview of the experiment?

3.2. Experimental Configuration

The configuration of the experiment details the set-up and conditions under which the experiment was conducted. This is a key section to make the experiment reproducible. Some helpful questions to consider include:
- What were the environmental conditions?
- What was the room temperature, audio conditions, lighting conditions, etc. (where applicable)?

- What time of day (or times of day) was the experiment run at?
- How were the evaluation metrics configured?
- What were the hardware settings (e.g. for computers that includes processor specs, processor speed, memory, peripheral devices specs)?
- What were the software settings (e.g. for computers that includes OS versions, programming languages, Libraries and Frameworks)?
- What were the data considerations (e.g. for computers that includes datasets, processing, cleaning, parameter settings)?

3.3. Experimental Procedure

The experimental procedure details that exact steps and processes followed during the execution of the experiment to ensure that others can replicate the experiment. Many of the details will have been mentioned in the Design section, so all we have to do is remind them of the broad ideas for content we have already explained, but for new content, we should describe it in detail. Some helpful questions to consider include:
- Do we present an overview of the experiment and how it ties to the research question?
- Do we explain the timeline of the experiment, when it started, how long it took, how long it task took, and were there any breaks during the experiment?
- Have we described the details of each step in the experiment, typically laid out in chronological order?
- Does the details of each step include a *Set-up Phase* (including any preparatory steps (e.g., loading data, setting up hardware, initializing variables)), an *Execution Phase* which explains how each task was carried out, and a *Data Phase* where we describe the results and data collection process?
- Do we mention any control variables, i.e. variables that are held constant so that the results are only influenced by the factors being tested? Additionally, do we explain which variables were manipulated (*independent variables*) and which were measured (*dependent variables*)? Finally, were there any steps taken to randomize inputs or experimental groups to reduce bias?
- Were the trials repeated? And, if so, how many times? And do we explain the rationale for the number of repetitions?
- Have we explained the measurement process, including the instruments, sensors, or software used for measurement, as well as how they were calibrated? If relevant, mention how often measurements or data samples were taken?
- If there were people involved in the experiments, do we explain how we choose them, and how we obtained their consent to do the experiments, and do we detail any instructions we provided to them?

This section is vital for ensuring that others can replicate our experiment as closely as possible, so clarity and detail are key in terms of fully explaining the experiment.

One additional and very important consideration is to ensure that we describe some of the constraints and challenges we encountered during the experiment phase of the project [7]. We don't want to sound like we are complaining or coming up with excuses when we are listing these issues, instead we need to emphasise that these were exciting challenges that allowed us to learn more about the research area!

3.3.1. Practical Constraints

This sub-section considers aspects of the experiment had to be simplified or changed because of practical constraints?

- If we ran a pilot, did we uncover any issues that need to be corrected, e.g. incorrect experimental set-up, ambiguous instructions, or improper metrics?
- Did we discover that the initial methodology is too complex or unfeasible in practice?
- Did any equipment, hardware, software, or tools malfunction in some way or limit what we actually implemented?
- Did any of the parameters need to be changed, maybe through trial and error to optimize the results? Also did any of the evaluation metrics need to be changed because they were not effective?
- If there is a dataset involved, did it prove to be too large and need to be split, or in some other way require modification?
- Did the estimate of how long tasks will take prove to be incorrect, and was there a need to simplify the procedure, reduce the number of runs, or decrease the complexity of the model?

3.3.2. Unexpected Challenges

This sub-section considers aspects of the experiment had to be simplified or changed because of unexpected challenges?

- When doing the experiment, did any new variables or confounding factors appear, requiring us to modify our experimental design to account for them or minimize their impact?
- When generating the results or data, do they contain random noise that was not considered during the design phase, requiring us to adjust our analysis techniques to filter or account for this?
- Were there any additional, unforeseen ethical concerns or security issues that required us to adjust the experiment or the approach?
- Were there any logistical Issues, for example, shipping delays, malfunctioning equipment, or resource availability that required changes in our timeline or other changes?
- If people are involved in the experiment, were there difficulties in recruiting the number or type of participants we originally planned for? Did they follow instructions as expected, or were there variations in behaviour that could skew the results or require adjustments in the methodology?
- Were there any environmental factors that altered the experiment (e.g. weather, location constraints, or equipment malfunctions)?

IV. PROJECT RESULTS

In this section we describe the findings of our experiment as clearly and concisely as possible. This section focuses on stating the results of the experiment with a minimum of interpretation or discussion (which we will save for the Discussion Section). We can use the following terms to find papers with similar content for this section:

🔍 "Research Topic" Results
🔍 "Research Topic" "Project Outcomes"
🔍 "Research Topic" "Project Findings"
🔍 "Research Topic" Deliverables

As mentioned previously, I have a RESULTS folder of 5-10 papers that presented their results in an interesting or novel way, and it can be very helpful to review those papers as I am writing this section of the paper.

4.1. Results Overview

The Results Section varies from discipline to discipline, but it is generally best to start off with an overview of the results with one or two sentences highlighting the key outcomes of the experiment; and focusing on the results that closely tie to the research question. Following this it would be helpful for us to have one more sentence that explains how the rest of the Results Section will be presented, including mentioning how the detailed results will be discussed, so we generally present the results based on some theme, for example, they could be presented chronologically, or presented by different evaluation approaches, or presented by the data used, or by some other suitable theme. Some questions to help develop this section:

- What are the key 3-5 findings of the experiment?
- Which of those findings are surprising and which ones are as expected?
- Do each of those findings address some aspect of our research question?
- What is theme, or themes, that we will use to explain and layout the detailed results?

4.2. Quantitative Results

So, as mentioned above, the details of the results are reported by some theme, and for quantitative outcomes, it would be typical to use Tables and Figures to accompany the discussion of each of the sets of results. If the results are based on large datasets, it may be worth reporting additional metrics such as accuracy, precision, recall, or other relevant measures based on our evaluation criteria. We may also wish to report the outcomes of any statistical analysis we undertook of the results, possibly presenting the significance levels (e.g., p-values) and the confidence intervals to indicate trends in the data. We may also have run comparisons between results, if we ran different trials within our experiment, and we can compare the differences in performance using metrics and visualizations, noting which trial performed better. We may also do statistical tests on these comparisons to explore whether these differences are statistically significant. So some useful questions may include the following:

- Does the theme, or themes, we have selected divide the results up into approximately even chunks?
- What Tables and Figures (or other visual aids) will we use to present our results?
- Is each Table and Figure referenced in the text?
- Which aspects of the results need to be discussed in a lot of detail, and which can be summarized?
- What metrics can we use to evaluate the results (e.g., accuracy, precision, recall)?
- What Tables and Figures (or other visual aids) will we use to present comparisons between trials?
- How will we highlight which trial, approach or technique performed better in our comparisons?
- Are the differences between trials, groups or conditions statistically significant?
- What important patterns or trends in the data have statistical relevance?

4.3. Qualitative Results

If the results are qualitative (e.g., case studies, interviews, textual data), then it makes sense to present the results by starting with a brief outline of the key findings and themes (and sub-themes) that have emerged from the analysis of the results. It may be worth including a sentence reminding the reader what techniques we used to do the analysis, and what steps we took to ensure rigour.

There is a saying that a picture is worth a thousand words, and I feel that a quotation is more impactful than a thousand words, so please add the participant voices to our results by using direct quotes from them to illustrate key points. I think it brings a real authenticity to the findings, so in terms of the quotes to select, we need to ensure that they are representative of our data, showing both typical and divergent views. Additionally, it is often overlooked in qualitative results, but we can create visual aids to accompany the results, clearly Tables and Figures are applicable, but also things like Mind Maps and Word Clouds can be an extremely effective way to communicate the relationships between content. So some useful questions include:

- What are the key insights or patterns observed from our results?
- Which aspects of the results need to be discussed in a lot of detail, and which can be summarized?
- How did we categorize or label our qualitative data, and what were the outcomes?
- What are some good quotations from participants that are both representative and atypical?
- What Tables and Figures (or other visual aids) will we use to present our results?
- Is each Table and Figure referenced in the text?
- Which aspects of the results need to be discussed in a lot of detail, and which can be summarized?
- How will we highlight which trial, approach or technique performed better in our comparisons?
- Have we over-generalised our findings in our explanation of the results?

4.4. Unexpected Results

Whether the results are quantitative, qualitative, or both, inevitably there will be some results that are unexpected or outlying in some way. It is very important to report these here in the Results Section, so that it is clear we are reliable and trustworthy researchers. So we will highlight the unexpected results in this section, and we address them in more detail later in the Discussion Section. This is particularly important if those results differ from your research question, because this shows our integrity as researchers. This just needs to be one or two sentences long in this section.

4.5. Key Takeaways

It is best to finish off the Results Section with a summary of the key findings of the research and how they relate to the research question. Remember, it is important that we avoid interpreting the meaning or implications of the results here, we are just presenting the findings clearly with sufficient detail and clarity. We should make sure that we include a sentence on the unexpected data, and another one on the limitations of the experimental approach. Our key takeaways will be concise, relevant, and provide a clear understanding of our research outcomes.

V.   DISCUSSION

In this section we interpret and explain the implications of the results, connecting them to the research question and the experiment. We also need to compare them and contextualize them with respect to existing results from the Literature. This section is very important as it helps make sense of the findings and demonstrates their contribution to the field. Here's some key questions to consider:

- Do we begin with a brief overview of the results, focusing on the most important findings, and how they support/refute the research question?
- Do we compare our findings to previous studies? Are our results consistent with or different from those found in the literature? Do we discuss possible reasons for any differences?
- Do the results have any implications for existing theories, models, or frameworks? Do the results suggest a need for changes in any of those?
- Do the results have any implications that could be applied to real-world scenarios?
- Are the limitations of our study discussed? Considering issues such as constraints in our data, methods, or experimental design.
- Are the unexpected findings of the research explained or are any hypothesis proposed? Why might these outcomes have occurred? Could they suggest something new or interesting about the research question?
- Based on the results have we proposed any areas for further research? Are there unresolved questions or new avenues that future work should explore?
- Do we end the discussion with a concise summary of the key conclusions drawn from the study

Some general suggestions on writing a research paper that I find helpful are as follows:

- *Emotional Engagement*: Social media algorithms know that if we can get people emotionally engaged (as opposed to just intellectually) they will be more deeply invested in a topic. So we should try to get ourselves emotionally engaged in writing this paper, if we can fall in love with the topic we are writing about, or hate it, or be really excited about learning more about it, then writing the paper becomes much easier. We should also introduce the topic of our research to readers in a way that will appeal to them emotionally.

- *Create a Schedule*: We need to develop a consistent writing routine that works for us, which means that we figure out when we work best. I find if I go to sleep for a few hours at night, and then I get up, my best writing times are 2am-5am. I love the peace and quiet at that time of night. So I guess I'm a "night owl", but other people are "early birds", and others like writing at normal times, So, develop a routine that suits you.

- *Writing in Chunks*: Break down the overall paper into small sections, and aim to complete one section at a time. This paper you are reading at the moment gives us a template to follow, so we can see as each section gets completed, and we don't necessarily have to write the paper in any specific order; we can write which sections we are interested in today. And we should figure out ways to reward ourselves as we are completing the sections.

- *Focus on Progress, Not Perfection*: We need to recognize that each step we take brings us closer to completion. As we are writing, we don't have to draft and redraft each sentence until we are happy with it, instead we should write as much as we can as quickly as possible.

VI. CONCLUSIONS

In this section there are six sentences we need to write:

- The first sentence needs to remind the readers of the research question.
- The second one is to summarize the key findings of the research.
- Next, we explain the implications of the research. We can also mention practical applications.
- Next, we highlight some of the possible limitations of the research. This shows transparency.
- Following that we suggest directions for future research in this area.
- Finally, we explain why this research is an important piece of work, and how it contributes to the field.

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APPENDIX A: RESEARCH PAPER CHECKLIST

Reviewing and evaluating other articles
A task sheet for students to work through several times and hopefully then internalise.

Name of article_____

Evaluation criteria	Notes
What type of article is it?	*Content:*
What is the main issue/problem being discussed?	*Content:*
Skim read – what could our research paper gain by including this article?	*Content:*
What is the article's contribution to knowledge?	*Content:*
How can this information be integrated into our review?	*Content:*
Compare and contrast to similar articles – are they for or against? Are they an extension of the literature?	*Content:*
Are there recommendations for further research?	*Content:*
Where is the article placed in our field? Famous author?	*Evaluation:*
Is the article well written, interesting and easy to read?	*Evaluation:*
Is there a clear research question – can it be tested?	*Evaluation of Hypothesis:*
What methods are used to carry out research	*Evaluation of the Research Design:*
Is the design appropriate for testing the stated hypothesis?	*Evaluation of the Research Design:*
What the limitations of the design/research methods?	*Evaluation of the Research Design:*
Are there aspects of the design that could be applied to our work?	*Evaluation of the Research Design:*
Are the results well displayed and clear?	*Evaluation of Data Presentation:*
Are the results in keeping with the design?	*Evaluation of the Research Results:*
Are the implications of the study clear?	*Evaluation of the Research Results:*
Have the results been appropriately discussed?	*Evaluation of further calls for research:*