A Concise Guide to Writing Research Proposal to IT/Computing Students

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ABSTRACT

The research proposal is a first and essential comprehensive document, which is prepared before commencing the research project. It reflects the important aspects of a research project such as what is a research project about, what are aim and objectives, why it is significant, what are the problems, what a proposed solution/system is and how it works, what are the expected outcomes, what are the methodologies to accomplish the aim and objectives, etc. In every University, the research proposal, written by the student must be approved by the department before starting the project itself. In this paper, the authors have presented a simple and stepwise guide on how to prepare a research proposal document. This guide will be very helpful to the students to gather important ideas for writing, structuring the research proposals properly and logically, selecting appropriate phrases in the sentences, and writing each section in a meaningful way. In this paper, the list of important sections of the research proposal has been presented. Each section has been explained in a simple, readable, and easy-to-follow way. Furthermore, each section is embedded with examples, phrasing helps, and writing steps so that students will be able to write on their own. Through this guide, the faculty who is supervising the research students can guide students in writing in a structured and uniform format.

Keywords: concept paper, IT projects, research proposal, research writing

1. INTRODUCTION

The research proposal provides the idea of the proposed project in a structured way. This should include what is the project about, what is the purpose of doing it, the justification for doing it in a particular way, what are the methodologies, what is the expected outcome, etc. The proposal should provide the relevant problems, and should formulate the central problems as research questions, upon which the whole project will be focused (Dawson, 2009). The research proposal should find out the relevance of the research through a state-of-the-art literature review. The originality and the novelty of the research work should be outlined properly and should state what would be the actual contribution of the research work to the scientific community (Gibney, 2018).

While preparing the research proposal students should take the following points in mind:

- Is the research topic relevant to your field of study?
- Why is this research project needed?
- Will it be an original/novel work?
- Will you be able to gather all the resources required to accomplish the project?
- Will this research topic boost/help your career goal?

- Do you have sufficient skills/ knowledge to accomplish the project or will you be able to learn the new skills to accomplish the project in time.

The aim of the final year project (FYP) is to develop new technical skills as well as personal skills for the students. Through the FYP, student work independently and make a contribution to the science that could be beneficial to others. In general, the Universities require the development types of the research projects for the B.Sc. IT/Eng/Computing students. For the information management types of students, analytical projects are accepted (Ekpoh, 2016). The FYP doesnot only involve developing the software or providing a solution to the stated problem but it also involves some contribution in science through research, justification of the context and evaluation/analysis of the result. The research proposals should be supported with sufficient and appropriate references. The resources can be found in journals, books, dissertations, government documents, reports, conference papers etc. According to the referencing rule followed by the University, the referencing format could be different according to the University's rule (APA or Harvard or IEEE).

Generally, the research proposal is written for contributing to the field in different ways. For example, the proposal can provide a new or different solution to the existing problem (upgrade type of proposal), the proposal can provide an existing solution to the new problem, and the proposal can provide a new solution to the new problem (invention type of proposal).

Research proposal writing tasks could be problematic if one did not understand properly the meaning of each section of the proposal (Wang & Li, 2008). In this paper, the authors have presented a clear idea of how to write each section properly. This guide should be taken for reference purposes only. According to the rule of the University for writing the research proposal, the format of the proposal and the depth of the content in each section may vary.

This section provided the introduction of the paper, and section 2, provides the detailed writing guide for each section of the proposal, which is the main content of this paper. Section 3 is the conclusion part of the paper.

2. WRITING GUIDE

There can be a word limit in the research proposal, which is based on the university 's guidelines for writing research proposals. In general, 150 words to 350 words are common, without including references.

Generally, the research proposal includes the following sections (in an order).

1. Abstract (followed by 4-5 keywords)
2. Introduction
3. Literature review (last 5-6 years works are most suited)
4. Problem statement (must have proper source information)
5. Aim of the research
6. Research objectives

7. Research questions
8. Significance of the research
9. Research methodology
10. Overview of the system/solution
11. Conclusion (followed by possible future work)
12. References

In the below paragraphs the guide to writing each section has been provided.

Abstract:

The abstract section is a summary of the entire research proposal which provides the meaning of the proposal. The abstract section should include the significance of the research, expected outcomes, goals, and processes/procedures to accomplish the goal and impact of the research. Generally, in a research proposal, an abstract is written in one paragraph with 150-250 words limit. Some researchers also write more than one paragraph in the abstract, mostly in a full research paper, which is also determined by the particular format of the paper. The abstract should be concise, readable, and meaningful. The lengthy sentences and dual-meaning sentences should be avoided.

The following steps can be carried out while writing the abstract:

a) Write a general introduction related to your topic (2-3) sentences.
b) Write goal/aim (1 sentence).
c) Write research significance/importance (why do you doing this research) (2-3 sentences) (b and c can be interchanged).
d) Write system development/design method (what you are developing) (present also core scientific work, novelty, or originality of your research) (1-3 sentences).
e) Write research methodology (online survey, case studies or experiment, or observation), and how the research will be analyzed (statistical analysis? If necessary) (1 -2 sentences).
f) Write hypothesis and impact statements (what are expected as an outcome of the research) (1-2 sentences).

Note: In the full research paper, the results of the observation/experiment/survey should be presented. However, in the research proposal hypotheses and impact statements can be presented.

Example:

With the advancement in AI technologies, various application areas have shown significant breakthroughs. The major reason for this is because of the features AI provides such as automation and intelligence. A Chatbot is a software tool that is used for simulating people's interactions in an online environment. Embedding AI features in a Chatbot provides various benefits in the banking sector. Such a system is not a new topic for effective customer interaction in banking sectors, however, its use might be a new technology topic for the banks in Nepal. In this research proposal, the need to investigate the various aspects of AI-embedded chatbots for providing efficient banking services in Nepal has been proposed. Through the survey, case study, and descriptive statistical analysis, the role of the Chatbot in enhancing the customer experience will be investigated. A suitable framework for implementing AI-embedded chatbots in the Banks of Nepal will be proposed. Lastly, various innovative ideas and

solutions for improving the technical and process-related problems will be proposed for the effective use of AI-embedded Chatbots in the Bank. After the research, the banking sector of Nepal will be benefited by understanding the various aspects of enhancing their customer interaction services with the use of modern technology.

Key terms:

Key terms are (4-7) keywords that reflect the research domain, goal, design/development/analysis method, and hypothesis of the research. One can write key terms in an alphabetical order.

Example: Artificial Intelligence (AI), banking services, Chatbot, data mining, machine learning

Introduction:

The introduction section is a general section of the research proposal. This section should include the introduction of the research domain, the connection of the research topic with the domain, the significance of the topic, and new knowledge/contribution/originality of the research (Honan & Bright, 2016). The introduction section should also include briefly what are you proposing, and which development methods/techniques/ideas the proposed system includes. The introduction section can be supported by suitable citations. In the end, the proposal's section overview can be given.
The following steps can be carried out while writing the introduction section:

a) Write the general introduction of the research topic and domain (3-5 sentences)

- Provide a brief introduction to the research domain.
- Relate your topic with the domain.
- Mention why your research topic is interesting.

Example:
Artificial intelligence (AI) is considered a significant technology in the modern world, for solving various tedious/repetitive tasks intelligently and in an automated manner. A Chatbot is a software tool that is used for simulating people's interactions in an online environment. Using a natural language, Chatbot can answer queries, do various pre-defined activities, and even provide the required information to the users like a human. Chatbots can be more user-friendly than traditional banking services for providing several services simultaneously to multiple users. AI-embedded chatbots can be used to converse with users intelligently. Because of the added advantages of automation and intelligence features, the research of Chatbot development with AI is attracting a lot of research interest.

b) Write general background of the research topic (3-4 sentences)
- Show some evidence from the previous work (literature) and establish why this topic is interesting and significant.
- Provide only the most relevant background information (not in-depth).
Example:

In the past, .. systems have been developed with ……technologies/methods. One important example of such a system is ……. A recent study shows that … can be improved with …….

c)Provide research problem and significance (3-4 sentences)

- State the problem, and what you intend to address (1-3 sentences).
- Mention in your proposed system/solution, what is/are original and important (1-2 sentences).
- What research gap is your work intended to fill (meaning is same as above).
- What limitations in the previous work will it address (meaning is same as above).

Example:
The present system/method/technology is lagging because of the …., concerning…., which are the major concerns .. for..... Different issues/problems arose because of …. To address such issues this project proposes to use/develop…., that will be --- helpful not only to… …like technology/system/methods are needed to be developed for …. (Efficiency, flexibility, easiness, smartness ….) that eases/helps/guides beneficiaries.
The proposed system will be developed with the state of art technology stacks ….. (.. library, framework, and devices)……., which are crucial to use/ to develop such a system. After integrating this technology with …, the important aspect of ….. (issues), can be expected to resolve, which will be very useful for ….. to the customers/students/peoples/residentials

d)Provide a summary of the rest of the paper
Example:
This section provided the introduction to the research work. Section 2 provides …. In section 3 ----are presented. Section 4 elaborates the …, and finally, section 8 concludes the paper.

Literature review

The literature review section provides the background for the problems which are going to address through the research. The literature review section should provide evidence of past literature which are important and related to the research topic and goal of the research (Karjono, 2020). The literature review helps to identify the problem area, significance (need) of the proposed research, and the gap/limitation in the previous research work done by others. It should establish the research topic is significant and relevant to the present context. It should provide a comparison of similar systems and should clearly distinguish them from the proposed research. Generally, the literature review is done earlier on as it is involved in finding the problems, the status of the current solution trends, and designing the suitable research methods (survey or others).

A literature review can be written without subtitles. However, it can be written by dividing into ‘research domain review’ and ‘similar system review’ sub-sections. The literature should be presented logically in chronological order as much as possible. The scholarly and recent resources should be presented. To connect the sentences, use good and reasonable phrases.

One can consider the following parts in the 'literature review' section:

1) Review in the research domain

The research domain-related reviews can be put in the following three categories:

i) Theoretical review (definition, advancement, in theory, what)
ii) Conceptual review/ (ideas/meanings/concepts, system /how)
iii) Empirical (experimental results, observation results, results-based)

In the theoretical reviews, literature in which the first theories proposed by authors in a particular research domain can be put. For example, the early theories of automation and AI can be put under this category. In the conceptual review, the literature related to the elaboration of the theories, concepts, and ideas which form the applicable systems can be put. In the empirical review, the literature related to the results of the experiments, surveys, and observations can be put (Kivunja, 2016).

2) Review in the similar systems

Steps of literature review:

a) Identify the key terms of your project and provide the theoretical review (2-6 sentences)
Example: Automated system, AI

b) Provide the conceptual review (3-6 sentences)

Example: Observe how the concept of embedding AI in Chatbot has been reviewed.

Chatbot with AI is considered that part of technology that is being used for conversation with users too intelligently. Using a natural language, Chatbot can answer queries, do various activities, and even provide the required information to the users like a human (Luger & Sellen, 2016). A Chatbot is not new because it has been in existence since the early 1960s in the form of ELIZA which was used for solving problems and language translation (Weizenbaum, 1966). In the period from the 1970-to to 1980s, there was a fast development in text & NL interfacing study as evidenced by Cliff and Atwell (1987), and Wilensky et al (1988). Since then, a slew of additional Chatbot designs has emerged, including MegaHAL (Hutchens & Alder, 1998), CONVERSE (B. Batacharia, 1999), ELIZABETH (Shawar & Atwell, 2002), HEXBOT (Hexbog, 2004), and AL-ICE (Artificial Intelligence Foundation, 2007).

c) Provide empirical review for your proposed system/design ((for evaluation purpose/results) (4-8 sentences))

Example:
The first result on AI embedded Chatbot shows that the algorithm/method/technique… is not very effective in terms of … The survey of …. finds that AI embedded chatbot is suitable if and only if …. The analysis results are drawn from …. which is very applicable for …? The survey results found in …, emphasize the significance of AI embedded Chatbot in the Banking sector, but not in .. …

d) Provide a similar system review (for comparison purposes. Provide examples of a similar app/ web app/IoT systems) (10-20 sentences))

Example:

With the use of AI in Chatbot, authors …. showed that ……. However such a system is not very applicable because of the …. Those improvements are not directly applicable in the context of …. Most of these, however, are not worth considering because of the …This has been influenced by …. which might be advantageous to …. sorts of applications.

In a summary, the following table shows the major differences between the proposed system (your) and other systems

e) Concluding paragraph (provide the significance of your proposed method/system/design) (4-7 sentences)

Example:

Instead of adopting ….. techniques/method/algorithm as proposed in …., this research will use …. techniques, that will be very important in enhancing the system performance. This framework, …., to design a mobile app might be very effective in terms of enhancing the features ….. The methods applied in …. It Will not be applied here, because of the …. Through this project the limitation in the …., will be addressed/overcome with…

Some phrasing help for the literature review:

In this work, the author evaluates…., these are influenced by…., … focuses on…., similar conclusions have been made by …., most of these, it is observed that…, however…, are outdated in the present context…., such conclusions reveal that…,

Problem statement

The problem statement states/describes the problems, because of that, the research has to be carried out. In this section, the author can raise the problems or issues regarding the topic, and research domain (Oates, 2010). The problems should be supported by the evidence from the literature, so that, the author should convince the reader that the problem is significant, which has not been addressed either completely, or partially by other literature.

Steps of writing the problem statement:

a) Identify 4-6 problems in your research topic and describe the problem.

Example 1:

Problem: lack of efficiency, lack of sufficient features

Many researchers have developed AI-embedded Chatbot systems. The systems developed by ….. are remarkable because of … . These systems have been developed with outdated

methods/technologies…., however with the modern advanced technologies such as… will be very efficient. In these systems, the……. features/methods are lagging, without these methods/technologies, the overall performance of the app, website, or device performance will suffer. Therefore, the investigation/development of .. system/software/app/website with these upgraded features/techniques is an important concern of this research study.

Example 2:

Problem: mental health issues because of pandemic

During the Covid-19 pandemic, people suffered from various mental health issues. In the study conducted by …, it is found that about 50% of the students suffered from some sort of psychological issues. … The study conducted by … is a major concern about the …. but not particularly on … There are not sufficient research studies conducted on this issue in the context of Nepal. Investigation of the mental health issues among undergraduate students in Kathmandu city is one of the concerns of this research study.

Example 3:

Problem: all the organizations are not ready to adopt new infrastructure because of the cost, additional resources, etc.

The implementation of the big data platform is a challenging task in terms of infrastructure development and finance. The assessment of the organization's readiness to implement such a system is a great concern.

Problem statements can be put in a sequence/order, because of the necessity of solving one problem statement over another. For example, in machine learning projects, finding a suitable dataset is the first problem before cleaning the data.

First problem statement: .... therefore finding/designing the suitable data set which fully represents the optimum characteristics of …. is one of the concerns.
Second problem statement: … therefore finding/developing a suitable method/algorithm/technique for cleaning/extracting the data before inputting into the ML model is another problem statement.

Research questions

The research questions are concise and meaningful questions extracted from the problem statement (Tanaka, 2020). The research questions are very important concerns to understanding the purpose and methods of the research. The research question states clearly what the research will investigate or attempt to solve. Writing research questions precisely will enable one to design research with a good chance of answering them. The good research question helps to identify the dependent variables (outcomes) and independent variables (predictors of dependent varaibles). The research questions should be relevant to the research topic, manageable to accomplish, clear, simple, and interesting.

One can separate the research questions into two parts:

a) Research domain-related research questions

Examples:

1) Compare and contrast the various network monitoring systems which have been successfully implemented to determine the components that proved to be essential
2) Will the targeted organization be ready to upgrade its IT infrastructure for supporting big data platforms?
3) What is the process involved in attendance taking of the staff within the organization?
4) What are the related (existing) Apps, people are using?
5) What are the approaches used in log file analysis?
6) How is the similar App helping with automatic farming?

b) Technical research questions

Examples:

1) Can the AI improve the Chatbot's performance with …? feature?
2) What are the optimum algorithms/methods/frameworks to fully implement the …. software which will be applicable in … with … features
3) Are there any significant relationships between the mental health issue of students and their satisfaction with online learning?
4) What is the hardware - tags and readers - that will be required for RFID Staff Attendance System?
5) How to Identify/develop the methods/algorithms to be used in testing the log file analysis
6) Determine the most effective method of testing a network monitoring system
7) Identify the various criterion for selecting a suitable development tool for developing a network monitoring system

Aim and objectives

The aim/goal sentence is a precise, concise statement that shows what the purpose of doing the research project is. This is a sentence for what is to be accomplished. The aim can be written in 1 sentence or maximum of 2 sentences. The aim sentence provides the solution statement of the problem, one is addressing.

Example 1:
The goal of this project is to develop a mobile APP that evaluates AI techniques for predicting the weather in Nepal.

Example 2:
This project aims to develop a model to predict the stocks' share prices of Nepal Stock Exchange. The user-friendly mobile app and Web app will be developed and launched for the commercialization purpose.

Example 3:
This project aims to develop an RF signal analyzer for WLAN site survey.

The objectives are the sentences that show how the aim of the project is going to be accomplished. Each objective should be clear, concise, realistic, and achievable. The objectives should be written in such a way that after the accomplishment of the objectives the overall aim will be accomplished. If there are steps in accomplishing the aim, the objectives should be written stepwise, that is, after accomplishing the first step (objective), 2nd step (objective) will be accomplished.

Objectives example:
-to perform the feasibility/market analysis for … ….system/App
-to identify and evaluate existing …. Apps for …. purpose
-to identify/develop/design the data set ….
-to extract/clean the data using...., …, perform data mining,…
-to identify/develop/implement the … suitable ML algorithm … for modeling, optimal performance of..
- to develop the mobile App…, with .. features for the commercialization purpose
-to compare and contrast the developed system/App with the existing similar systems/Apps

Overview of the proposed system

In this section, the proposed system has to be presented in detail. It includes an explanation of what is it and how it works. The author should describe how the proposed system can address the stated problems of the problem statement. To clarify these points the author can provide a functional diagram, block diagram, and data flow diagrams if applicable (Lin & Morrison, 2021).
Steps:
Explain

1. What is it, what technology/methods/process/tools will it be using?
2. What it does, where it will be useful.
3. How it works:
    1. Present the functional block diagrams/flowchart/data flow diagram according to the nature of the project.
    2. Explain the working principle (explain the steps from beginning to end).
    3. Explain what resources are required to accomplish the project.
    4. Explain if there are sequences of development stages in the system.
    5. Explain the reasons for doing it, with your techniques/methods/tools/frameworks, (what are the benefits).

Research significance

In the research significance section, the need for the research work has to be clarified. In another word, it is a justification section, in which, the author has to convenience the readers that the research is 'significant' and worthy (Maher & Milligan,2019). This section provides the answers to why research work is needed, what value/s it brings to the beneficiaries, how valuable will be the findings etc.

Steps:

1. Explain your research problems briefly.
2. Explain briefly how the status of the current literature is to solve the problems.
3. Explain briefly what original/new/update/modification, you are going to accomplish.
4. Explain why this method/technique is unique and important.
5. Explain, who will benefit after the accomplishment of the project.
6. Explain how it impacts society on a national level or internationally.
7. Explain how in the future your findings might be beneficial.

Research methodologies

The research methodologies section provides the ways of accomplishing the research goal such as methods of collecting and analyzing the data, resources management, project management, risk/safety management, etc. This section provides the methodologies of achieving objectives or answering research questions of the project (Creswel J. W. & Creswel J. D, 2018).

Steps:

1. Provide what resources will be used for data collection and analysis.
2. Provide the clear idea of accomplishing each objective or research question such as, will it involve survey/case study/experiment/observation for the data collection?, how the sampling will be performed ?, which form of research is it qualitative or quantitative?
3. How the data analysis has to be performed, and why. Will it involve statistical analysis? Are there any limitation while collecting the data and analyzing procedures?
4. Mention if there is any pre-determined risk/safety issue.

Conclusion

Conclusion is a last section of the research proposal. This section should present the clear summary of the main points of the research.

Follwing steps can be followed to write the conclusion section:

- Restate the research domain and topic.
- Restate 'what' and 'how' you going to develop/implement your proposed system (with originality).
- Restate the main expected outcomes.
- Restate the major significances.
- Provide the possible future perspectives/future work.
- Conclude with your opinion.

3. CONCLUSION

In this paper, the authors presented a concise guide for writing a research proposal for IT/Engineering students. Through this guide, students will be able to write the research proposal for their engineering/IT research projects in a well-structured and meaningful way.

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