Proposal Development and Writing Template for Students in MSc Program of Geomatics Engineering

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Proposal Development and Writing Template for Students in

MSc Program of Geomatics Engineering

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Dept. of Surveying Engineering

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1. An Overview:

The main purpose of a research proposal template is to develop a well-written document that has the potential to add a new result or contribution as an effort of an organized research process. This research process can be validated against the general methodology and framework of science. This document or template was developed to guide you through the different aspects of proposal development and writing. Your research proposal is a communication tool between you and your expected readers and audiences. Your media of communication is a written document for your proposed work. In particular, this document should be able to explain very clearly and without ambiguity the significant of the expected contribution or results of your proposed work, its impact or value, its innovation, and to position this work or contribution within the existing web of knowledge. In short, the main objective of a written research proposal is to present a roadmap in order to claim a new knowledge in light of the existing ones.

Your written proposal should be approved by your committee; otherwise you cannot proceed in your research work without their approval. In other words, you need to know what is expected from you in order to be approved. **In bold words**, your proposal should satisfy and address a basic set of well-established and well-known criteria in order to be accepted and approved by your committee, which will be explained in this document. At the core or the heart of your research proposal development is what is called "The Problem Statement or Research Question/s", which is the driving force behind what you are trying to do during your research period. The Problem Statement can be viewed as a steering arm to generate the expected outcomes and contributions after finishing the stated work in your research proposal. In concrete words, everything and every section in your proposal should revolve around your problem statement. Simply put, all of your research work and activities will be structured around your chosen Problem Statement or Research Questions. Therefore, make sure that you have a clear and well defined Problem Statement in your proposal; otherwise you may be trapped in a vicious circle. A written proposal without a well-articulated, presented, and explained Problem Statement is Useless. Although the content of your research proposal is more than a problem statement, it is the central theme or the building block that governs your development, thinking, investigation, literature review, experiments, simulation, and the whole process of your proposal writing and development. This problem statement has to be developed, hypothesized, postulated,

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given by your advisor, or discovered and objectively justified by your research proposal. It is very critical to state that real or practical problem statements that address the needs your society and your country are of great values and importance. In fact, practical and applied research is the basis of economic prosperity and poverty reduction. As such and regardless of the nature of your research problem, one of the main objectives of your research proposal is to defend your problem statement; and this is without saying explicitly or directly I'm defending my problem statement. More details will be given in this document about how to develop and justify your problem statement. In general, your proposal is a set of coordinated, creative, well-written, and well-blended activities or plan to overcome the challenges that will be presented by your problem statement or research question/s in order to generate a new value or a contribution.

Proposal development and writing may not be a trivial process or task for the beginners and new comers to the research world; and it needs to be explicitly explained, outlined, discussed, and presented in a well written document. On the other hand, the development and writing of a research proposal should not be viewed as a black box or a magic business at your end. This black box should be opened and decoded to understand its content and messages at your side before being checked and read by your reviewers or committee. Well developed and written proposal is a critical milestone and achievement in your research work and even for your whole career and future. The document between your hands can be viewed as an information processing model to develop and to write a research proposal. In particular, it will facilitate the communication of the scientific ideas that underlay your research proposal. Its main objective is to ease and to reveal the hidden complexity of proposal development and writing; and makes it accessible to a wide range of users and new comers to the research world. That is said, proposal development and writing is a non-linear and iterative process that requires a dedicated effort and time in order to get it done in an acceptable manner. Before you start the development and the writing process of your research proposal, please read this document 2-3 times to be familiar with the process itself.

This document or template provides the necessary guidelines and a roadmap for the process of developing and writing a research proposal at any level of your graduate works (Higher Diploma, MSc, & PhD). The current Master Program in Geomatics Engineering at University of Khartoum-Sudan has two tracks. The first track consists of two semesters and a research project with a thesis. The second track consists of three semesters and a technical papers. This template can be used for both tracks. It is well applicable to the proposals for technical studies and funded research work from different organizations. This document can be seen as the **blue-print** or the required thinking process in order to develop your research proposal. Even though this document is targeting geomatics students, it can be used by students from all other departments of engineering and other specialties such as geology and physics. While this document is written with an engineering tone and mindset, it can be used with other communities with some minor modifications since it is based on the general idea of the scientific method.

Much of what we learn at the early stages of proposal development and writing depends on our ability to understand written materials and documents. Thus, the comprehension of this document or template is an important step towards the development and writing of a good research proposal. Good proposal is a coherent and clear document that is well written, well structured, and well

connected from the first word to the last sentence. Typically, this coherency is the result of your initial understanding of the theoretical and technical aspects of your research problem as well as the in-depth understanding of the process or the mechanism of how to develop and write your research proposal. On the other hand, the lack of coherency and clarity is a sign of not well researched problem as well as a basic lack of understanding of the underlying process that governs the proposal development and writing itself. Therefore, a good written proposal will be built on two elements, namely, initial understanding of your research question/s or problem statement; and a basic understanding of the process of proposal development and writing. The word **initia**l is very key since during the actual research work some facts may change due to theoretical and/or experimental findings but this word is fully acceptable to start your research work. In general, good and excellent proposal highly depends on an in-depth reading of your research area or subject. Although the reading component of proposal development and writing will be discussed in the literature review section, an early and accumulated reading in your area of interest will be of great value and help in your research journey.

As stated, proposal development and writing is a highly non-linear and iterative process. For example, you need to do the literature review section first and then you come to the motivation section. In other words, the layout for the proposal writing as shown in this document does **NOT** imply a general sequential order for template filling or development. Yes, we need to follow this order to present your work as a written document but the thinking and filling processes about how you are going to develop your proposal are highly non-linear and do not follow a sequential order.

2. **Title of your Proposal**:

The **initial** or the **given** title of your proposal is called the **working title** to serve as a place holder, which may change during or after the execution of your research work. In simple words, this is a title for your current proposal and may not be the same title for your technical paper or thesis or even at the later stages of your proposal development. It is just a working title. Your title should be a reflection or a mirror of your work or a solution for your problem statement. The title can be viewed as a positive answer to your problem statement or research question/s. Your title is a bridge between your problem statement and the proposed solution. Always you need to ask yourself the following question: Does the title of my research proposal gives an answer/s to your problem statement, if not, you need to search for a proper title. Lack of a good title is one of the signs of not well understood and researched problem statement. During or after the execution of the project you may need to change the title to reflect the actual content of your research work. In general, a good and a sound title is very key for your work since it will provide an excellent guide and pointer to understand the different aspects of your research work. Short and compact titles are highly preferred than the longer ones. The **Title** of your research work could be used as key words in the **Internet** to search for relevant information, books, blogs, forums, websites, journals, previous work, and literatures that cover the different aspects of your envisioned research work.

3. **Proposal Summary:**

This is a one paragraph (100-250 words) that gives a short summary and an overview for the content of the whole proposal. As stated, it should revolve around your problem statement. This summary should cover the motivation for your work, the problem statement, the methodology, and the expected contributions and results. Proposal summary is equivalent to the abstract in a technical paper or a research thesis but it does not include concrete results or findings since the research work is not executed yet. For this particular difference, we avoided the name "Abstract" and replaced it with "Proposal Summary". Sometimes a proposal summary could include some preliminary results along the main lines of the problem statement of your research work. In terms of writing, this is the last section that will be written and added to your proposal document because the overall picture of your work will not be developed or emerged until you do the other sections.

4. **Keywords:**

You need to list the keywords of your research work. As a general rule, your keywords should capture the contents of your **Title** and the **Proposal Summary**. For example, assume that we have the following title for our proposal:

"Automatic Relative Orientation and 3D Surface Reconstruction Using Cross-Correlation Image Matching"

Then our keywords may look like this:

Keywords: Automatic *Relative Orientation, Cross-Correlation, Image Matching, 3D Surface Reconstruction.*

You need to observe that the order of the keywords is not random and it follows a logical process that reflects the underlying dependency of the work itself; and it goes like this:
In order to do automatic relative orientation you need a cost function (here refers to: cross-correlation) for image matching and then you can proceed to 3D surface reconstruction. In other words, it is very illogical to put the 3D surface reconstruction before the image matching. As a general advice, please order your keywords in a logical sequence to capture the underlying dependency of your research work. After you write the keywords, ask yourself the following question:

Does the keywords capture the title and the content of the proposal summary? If the answer is NO, please review your keywords and your basic understanding of your research work and your problem statement. Improper set of keywords, is a sign of a major problem and knowledge gap in your research work.

5. **Motivation**: Why you are doing this research? You may take this as an example:

Obstacles detection and terrain mapping are very critical for the safety of air traffic navigation at different stages of takeoff, landing, and route's navigation of airplanes. Therefore, the development

and update of obstacles maps is a mandatory task for safe air navigation, which is the main concern of this project or research work. In particular, this project will investigate the use of close range photogrammetry for obstacles detection, measurement, representation, and mapping to update the existing database or develop a new one.

In this section you need to list the core issue/s of your research work and how you are going to address them in a very general way. Do not give details at this section. Only high level information. Indeed, your motivation section will be shaped by the implicit and/or explicit information and knowledge that will be gained during the process of the literature review and the **initial** understanding of your problem statement. In simple words, your motivation section should suggest a need or a set of needs to study your problem.

6. **Introduction**: You need to provide a general background information about your proposed work. You can put more details about the motivations in this section. You need to highlight and touch your Problem Statement very briefly in this section but with simple clarity. In particular, you need to show how it is related to the general background of your research area.

7. **Terminology and Abbreviations**: You need to define and explain the main terminologies and key concepts or techniques that will be used in your work. For example, you may list and explain the following:

   a. CRP: **C**lose **R**ange **P**hotogrammetry.
   b. Camera Calibration (you need to add the definition or explanation).
   c. Space Intersection (you need to add the definition or explanation).
   d. Space Resection (you need to add the definition or explanation).
   e. Relative Orientation (you need to add the definition or explanation).
   f. Data Fusion (you need to add the definition or explanation).
   g. Data Mining (you need to add the definition or explanation).
   h. Machine Learning (you need to add the definition or explanation).
   i. Geodetic Network (you need to add the definition or explanation).
   j. GPS (you need to add the definition or explanation).
   k. SVM: Support Vector Machines (you need to add the definition or explanation).
   l. Line Generalization (you need to add the definition or explanation).
   m. Hough Transform (you need to add the definition or explanation).

8. **Literature review:**

Literature review is one of the main building blocks of your research proposal. Without a literature review section in your proposal, your proposal document will be of no value and it cannot be defended or approved by your committee. In-depth reading, revision, analysis, notes taking, and understanding of previous work or literature is one of the main drivers for excellent research work. The familiarity with the existing literature in your field of study should start very early in your graduate work; and this is will help you to develop an interest in particular area of your specialty. Sometimes you may

need to read in other fields to extract new ideas for your research work. The main objectives of literature review section is to provide the evidence and proof for your problem statement or even to discover your problem statement as a result of gap analysis and knowledge synthesis. In one hand, this evidence for your problem statement will be guided by the knowledge gaps and recommendations that were stated in the previous work. On the other hand, the literature review may pave the ground to suggest radical and innovative ideas to solve longstanding problems and issues in your particular field of study. In general, previous works that are related to your research work should be explored in order to provide a context or a framework to justify your effort and energy that will be invested in your research work. The following guidelines should be observed while you are developing your literature review:

- Relevant literature to your work should be used and cited. Irrelevant literature should not be used.
- 10-20 papers should be reviewed for the technical paper. More papers should be used for a research proposal. Not every paper will be cited in your proposal. Only representative papers should be used. Relevant papers with high number of citation are good candidates for citation in your proposal. For example, you can use Google Scholar or Researchgate to find the number of citations for different papers. In general, the actual number of papers depend on the type of the problem that will be addressed by you work and the specific angle or perspective that will be chosen to do the work. Typically, the angle or the perspective of your proposal could be obtained from your problem statement, which will be explained in the next section. Literally, your research work can take any angle within your research field.

- Literature review should be discussed in light of your research proposal; and in particular, it should support your problem statement or research question/s. It is not just a mere citation or listing of existing work that is somehow is relevant to your proposal but not really reflect what you are trying to do.

- As stated, the actual number of papers depend on the nature of your research work. The ultimate goal of the literature review is the provision of a background information and knowledge for your research work and more importantly is the provision of a justification in the court of objective opinion to do your research work; otherwise you may end up with the situation of reinventing the wheel by repeating an existing work. The literature review could show a theoretical gap in your topic and your current work will try to fill this gap. In a different project, the literature review may reveal that a benchmark study is required to compare the performance of different approaches for relative orientation. In other words, the revision of several papers may reveal a certain knowledge gap that may not be trivial from one or several papers. As such, the problem statement of your proposal will not be listed in one of your read papers. It is the collective analysis and understanding of your literature review.

- In addition to the technical research papers or articles, you can use different sources for your literature review such as text books, websites, and personal communications. Proper citation in the reference section should be used for the different sources of literature review.

- While you are doing your literature review, you need to connect the dots between what you read in terms of papers, books, and website. In particular, you need to perform the following activities:
  a. Strategic use of the literature review to support and position your problem statement.
  b. To distinguish between different ideas that were presented by different papers. You need to make a list for the advantages and disadvantages or shortcomings of each idea. Sometimes you may need to test some of these ideas before jumping to any conclusion.
  c. To find the relationships between the different ideas from different papers.
  d. Look to the different ideas from different perspectives or angles. For example, the first paper suggested a camera calibration based on points; and the second one suggested camera calibration based on straight-lines. Then a new angle or perspective could be like this: how to combine points and line in one unified mathematical model to alleviate the shortcomings of each one of them? Or we have to combine them in a serial and iterative model that estimates the calibration parameters based on points at the first step; and use these parameters with lines as prior knowledge or constraints at the second step and then proceed in an iterative update for points and lines?
  e. How to use these different ideas together to form a system of bigger ideas.

9. **Problem Statement**

   Problem statement is the single most important section of your research proposal that influences the whole process of your research work. It provides the rationale and motivation for conducting your research work. If you cannot provide a convincing argument in your problem statement, then there is no justification for proceeding. You need to come up with a problem statement for your research work.

   A certain idea or concept will be embedded in your problem statement. This idea will be revealed by the process of question asking. Therefore, you need to formulate the research question/s of your work. You can use one or more question for this task. For example, it can be done like this:
   a. The first question it could address the basic idea of your work.
   b. The second question could address how you are going to evaluate this idea.
   c. The third question could address the shortcomings of your idea.

10. **Specific Objectives of your research**: In general, you need to list 2-3 objectives of your research work. In this section you need to stress on the chosen angle or perspective of your research work and the types of expected results and contributions. There is no need to discuss your tools, instruments, software, and tasks at this section. Just you need to specify the expected end results that can be obtained during the research period. From a management perspective, you need to apply the five properties of an objective. An objective should be **s**pecific, **m**easurable, **a**ttainable, **r**elevant, and **t**ime-limited or bounded (SMART). You do not have to write these properties, but they should be implicitly embedded and understood within your listed objectives.

11. **Theoretical approach**: You need to list the physical and the mathematical principles of your research. This is the science part or the basis of your research work. The mathematical and physical aspects of

your problem statement should be presented in this section. This is the conceptual basis of your research work; otherwise you **do not** have a solid ground to do your research work.

12. **List instruments, hardware, and software:** that will be used in your work. If yes, show how you are going to obtain this permission. If no, write Not Applicable or for short (**NA**)

13. **Do you need a permission to do your work?** For some types of research work you may need to obtain a permission before the start of your work. If your answer is YES, then you need to discuss how you are going to obtain this permission. If your answer in NO, leave this section empty and write the word **NO**.

14. **List the required field work, Lab work, and data sources**. For example, your field work may look like this:
    a. Visit the study area.
    b. Arrange with your supervisor to obtain the required permission/s (if you need it).
    c. Obtain the permission/s to do your field work in the study area.
    d. Acquisition of aerial images using Unmanned Aerial Vehicle (UAV).
    e. Measurement of ground control points using Real Time Kinematic-Global Positioning System (RTK-GPS).

15. **Experimental setup**: This task is directly connected with the required field or Lab works for your research work. For example, your experimental setup could be like this:

    a. In this project five experiments will be conducted for change detection between six epochs or periods using six satellite images. Therefore, a prerequisite for change detection is the acquisition of the images.
    b. In this project different sets of stereo-pairs will be acquired to evaluate the impact of different geometric configurations on the geometric accuracy of the exterior orientation parameters as well as the camera calibration parameters. In particular, Unmanned Aerial Vehicle (UAV) will be used for image acquisition. This set of images will be augmented by another set of close-range images to test the stability of parameters estimation in terms of the variance-covariance matrix.

16. **Methodology**:

    The main purpose of the Methodology section is to develop an operational procedure upon which you can test and evaluate the different aspects of your problem statement or research question/s. As such, the methodology section is a direct response to your problem statement. Algorithmically, a methodology is an unambiguous specification of how you are going to solve and address the underlying issues of your problem statement in a systematic way. The methodology section describes how the results or the expected contributions from your research will be obtained or generated. In simple words, it is about how you are going to do your research work in a step-wise approach or a procedure. **Practically**, methodology is the core of your research work and as stated it should be

developed very carefully to answer or to respond to the stated questions in the problem statement section. You can use the gained understanding from the previous steps to guide the writing process of the methodology section. It may seem like a redundant work but it is **NOT**. Yes, it uses information from the previous sections but in a combined and complementary ways. Your methodology reflects and conveys a coherent picture and a very specific understanding of a stepwise approach or procedure of your work to address the problem statement. Moreover, it should reflect a logical order and dependency between the stated steps or tasks in the previous sections. It is not a random listing of steps or operations. Lack of a well-developed methodology is a sign of not well-understood problem statement; and more time is needed to comprehend your anticipated research work.

17. **Expected Contributions and Results of Your Work**.

We need to differentiate between engineering projects and research projects. This differentiation is very critical to the overall understanding of the research process; otherwise we may end up with a beautiful work that is not relevant to the very basic idea of research. Although we can find some overlaps or shared characteristics between the two types of projects, research projects are mainly concerned with advancing our knowledge or the-state-of-the-art by answering the set of questions that were stated in the problem statement section. These questions will be asked from a specific point of view or **angle**. The word **angle** is very key since every research project will advance our knowledge from a certain angle and not all directions; otherwise it may lose its focus and perspective. On the other hand, engineering projects are typically based and grounded on well-known sciences and best practice; and this is does not deny the fact that sometimes research issues may emerge during the execution of challenging projects.

Engineering projects are typically concluded with deliverables and specific outcomes as main results. The deliverables will be dictated by the stated guidelines in the scope of work or the terms of reference (TOR) for the specific engineering project. On the other hand, research projects are typically concluded with contributions and findings as well as recommendations for future work. The contributions and findings will emerge as a direct response and answers to the questions that were stated in the problem statement section.

You need to list your expected contributions either as bullets or in a paragraph. In addition, your research proposal could be backed-up or supported by preliminary experimental results to demonstrate the initial feasibility of your research work. These experiments should highlight some of the key issues of your research work. You do not have to show the whole issues of your research work. Just present snapshots of some experiments of your research work that are relevant to the key questions and challenges that will be addressed during the actual research. Preliminary experiments will add creditability to your proposal and could stimulate fruitful discussion during the presentation of the work. As such, preliminary experiments and results are very welcomed and recommended for inclusion in your research proposal.

18. **Use of Objects such as Figures, Maps, 3D Models, Pictures, Diagrams, Flowcharts, Graphs, Trees, Tables, and Dashboard**:

It is very much advisable to use these objects during the development and writing of your research proposal since they will clarify your work as well as amplifying your creative thinking for more positive stimulation and imagination. For example, diagrammatic representations help us to represent the underlying structure of our research or problem statement that will put us in a strategic position to conceive a better methodology and solution. It should be noted that many scientific discoveries depended on visual imagery, and indeed, you need to represent your research ideas in terms of images and other graphic objects. For instance, Einstein reported that his thought experiments relied on imagery.

19. **Organization of the Research or the Technical Paper**. You need to list the names of the chapters (for research project) or the sections (for technical paper) of your work. This organization may change a little bit after the completion of your work, which is very normal and acceptable.

20. **Research schedule**:

 You need to develop a time table on how you are going to execute your work. Your research schedule should be tied to the content of your research work that was mentioned in the previous step.

21. **Research budget**. How are going to finance your project (if any).

22. **References**. The majority of the references will be mentioned in the literature review section. Yes, very few references may be used in other sections of your proposal. You need to use the proper format to cite your references.

23. **Checklist:**

The following checklist shown in Table 1 explains the contents of your research proposal document. It help you to monitor and manage the progress of your work.

Table 1: Checklist

Sr. No.	Activity	Status (Use Completed, Not Completed)
1	Title	
2	Proposal Summary	
3	Keywords	
4	Motivation	
5	Introduction	
6	Terminology and Abbreviations	
7	Literature Review	
8	Problem Statement	
9	Specific Objectives of your Research	
10	Theoretical Approach	
11	List instrument, hardware, and software	
12	Do you need permission to do your work?	

13	List the required field work, Lab work, and data sources	
14	Experimental setup	
15	Methodology	
16	Expected Contributions and Results of Your Work.	
17	Organization of the Research or the Technical Paper	
18	Research schedule	
19	Research budget	
20	References	