

Dr. Norbert Cheung's Lecture Series

Level 5 Topic no: 35

Research Proposal Development

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Reference

Engineering Research: Design Methods and Publication, Herman Tang, Wiley, 2021.

1. Research Initiation

From ideas to problems:

1. Briefly describe the problem
2. Prepare a problem detail description:
 - **The situation in the context of a system**
 - **Inputs and outputs of the system**
 - **Functions of the system and subsystems**
 - **The system's structure and relationship among the subsystems**
 - **The system's environment**

Idea Evaluation

1. Create a simple checklist:

No.	Question	Yes	Maybe	No
1a	Will this contribute or extend human knowledge? (for basic research)			
1b	Will this generate a new method, understanding, or solve a major problem, etc.? (for applied research)			
1c	Will this invent a method, an artifact, or solve a practical problem? (for engineering R&D)			
2	Will this be a systematic study with a feasible plan?			
3	Will this be assessed for internal and external validity?			
4	Will this be meaningful and impactful to community?			

2. Three Cornerstone of Research Proposal:

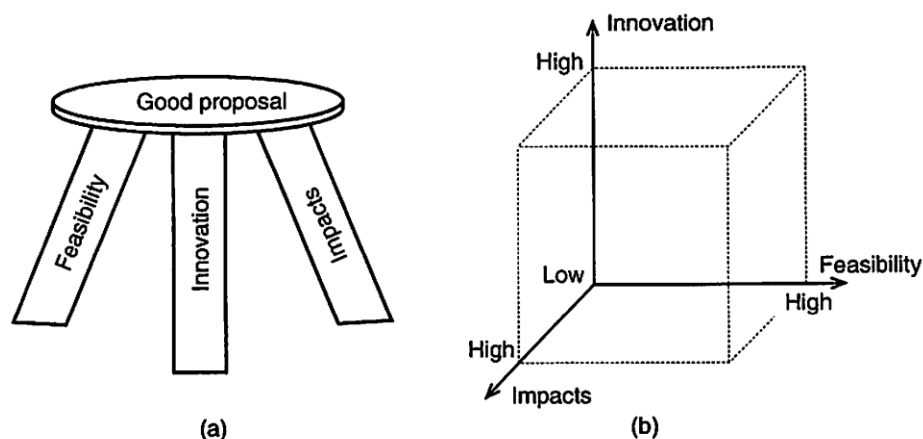


Figure 2.1 Three cornerstone of research proposal. (a) Proposal stool model. (b) Measurement of proposal quality.

Student Research Development

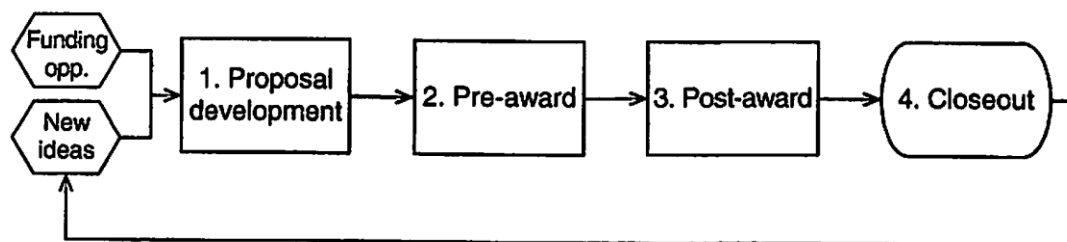


Figure 2.2 Four phases of research lifecycle.

Student research proposals may be short, but the development process is about the same and its composite parts are similar. The development of a student research proposal may be viewed as a guided independent study.

The funding sources for student research are either part of faculty research grants or supported by university programs. The various funding opportunities have different requirements, so readers should check the particular requirements of funding programs.

Example: University of Berkeley guideline:

1. Statement of Purpose (one paragraph, 150–175 words)
2. Background and Justification (1.5–2 pages)
3. Project Plan (1.5–2 pages)
4. Qualifications (1.5 pages)
5. Budget Plan (0.5 page)

A more detail map:

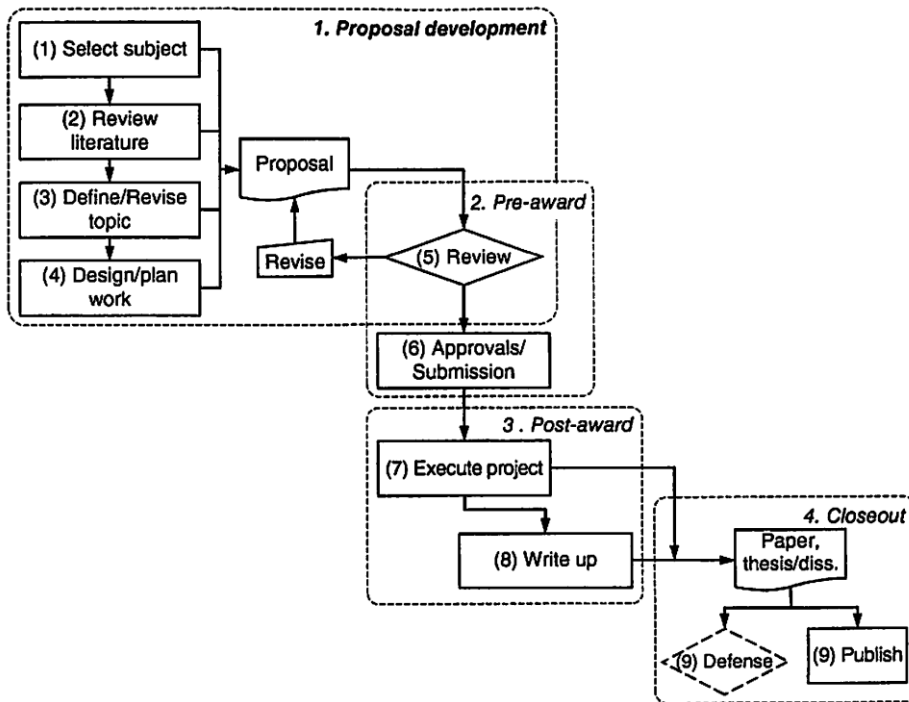


Figure 2.3 An overall process flow of research project.

Hypothesis – For Basic and Applied Research

An educated guess and prediction for research outcomes.

A research hypothesis is often stated in two parts in a format of H_0/H_1 :

- **Null Hypothesis (H_0).** It is the statement of a default position, assuming no statistical significance exists in a set of observations until evidence indicates otherwise.
- **Alternative Hypothesis (H_1).** The statement describes the other possible outcome, which often is set as researchers would expect and predict.

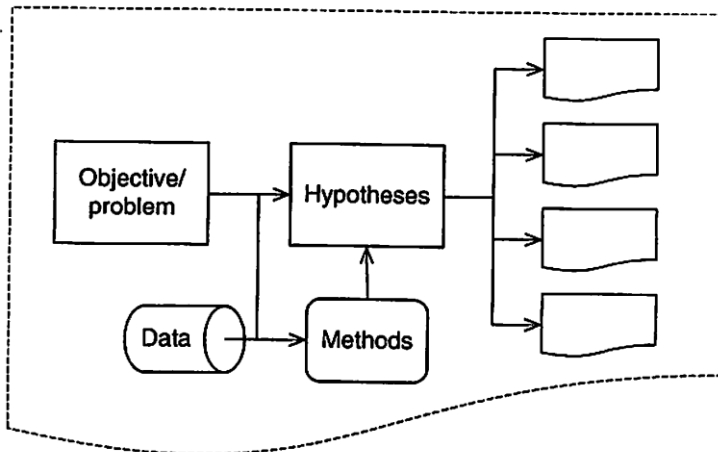


Figure 2.4 Structure of proposal description with hypothesis.

In engineering research projects, the hypothesis may be stated either explicitly or implicitly. For a simple example, of testing new product performance, the hypothesis may be

- H_0 the new product has the same performance
- H_1 . The new product has better performance

2. Composition of Proposal

In a university, a student proposal may have specific formats. Below is the general format of research proposal:

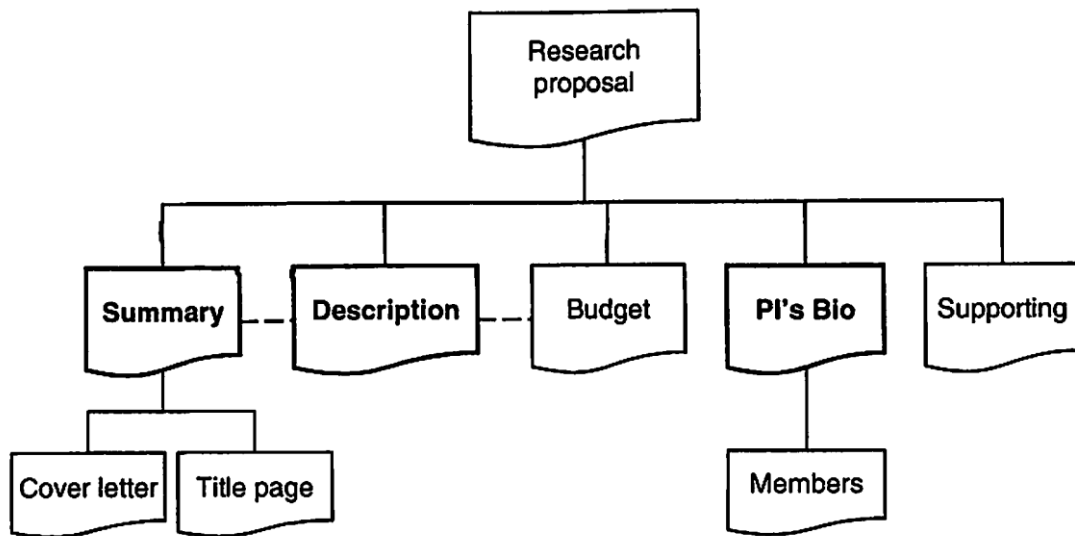


Figure 2.5 A typical organization of research proposal.

#1 Research Objective:

We may write an objective as “The objective of this research project is” The statement of a research objective should not be very long, often less than 25 words. Considering the necessity of conciseness, crafting an attractive and clear objective statement may be challenging. It is very worthwhile to try to revise an objective at least five times.

#2- Research Summary and Description:

The project description of a research proposal is a complete narrative. The requirements for a project description vary significantly. For many government agencies, the page limit is 15 pages. For the proposals for the dissertations of doctoral students, the length could be significantly longer.

1. Introduction and proposal overview
2. Background and significance of the proposal with literature review
3. Research plan (tasks and timeline of the project with justifications)

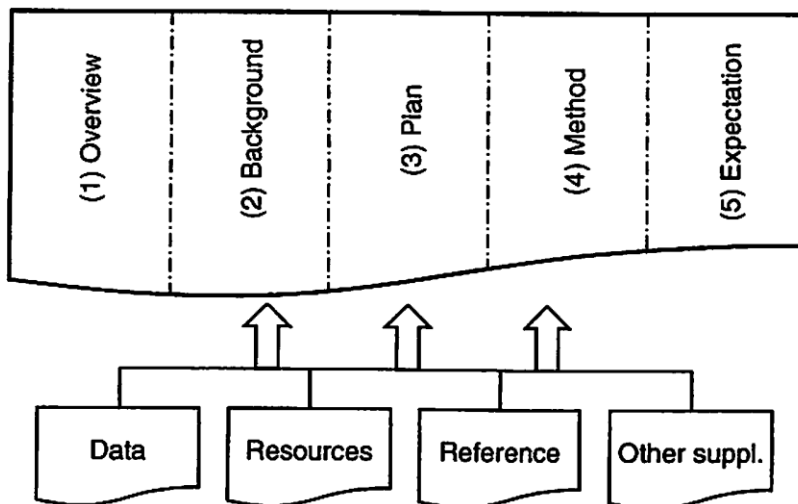


Figure 2.6 Elements of research description.

4. Methods to be used and data availability
5. Expected outcomes and summary

#3 *PI (Principal Investigator) and Team*

For master’s theses and doctoral dissertations, graduate students are the PIs who work closely with their faculty advisors to develop proposals and conduct the research work, as student’s tasks are often part of faculty advisor’s research projects.

#4 *Budget Plan*

A detailed budget plan is an integral part of a research proposal. Separated from technical reviews, the budget review is conducted by the financial and administrative professionals in funding agencies to ensure the eligibility, justification, and in accordance with applicable policies.

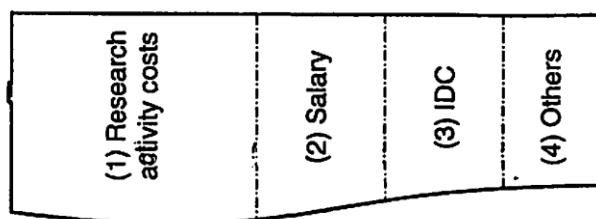


Figure 2.7 Elements of proposal budget section.

IDC: indirect cost. e.g. clerical services, administration charge, etc.

#5 Supporting Material

The supporting materials include the references cited, ongoing and pending research projects, resources (e.g. facilities, equipment, and personnel), data management plan, management support, and applicable collaboration. All of that information will be considered in the feasibility evaluation of a research proposal.

3. Proposal Development

Essential Issues

#1 Meeting Requirements

The final version of a proposal must fully align with the mission and all requirements of the funding program. Research sponsors are normally mission-driven and have well-written proposal instructions. Different sponsors have varying terms and requirements. For example, the NSF has its specifications, Research Terms and Conditions (NSF n.d.-b). Other federal agencies, such as the US Department of Energy (**DOE**), have their own specific requirements. Any deviation from the applicable requirements, even in an innovative way, can result in being screened out without technical review.

#2 Planning for Outcomes

Consistent with the research objectives, the anticipated outcomes may be stated in a proposal, which serves as solid information for the evaluation of academic value and feasibility of a project. However, it is impossible to predict all eventualities and the outcomes exactly. We may make an educated “guess” regarding the nature and scope of the outcomes and their benefits, such as the expected impact and contribution to a specific field.

#3 Methods Overview

The number of methods for research is virtually unlimited. Every proposal may have different methods and approaches, even in the same field or on an identical subject. The methods used in a research project include analysis, modeling, case study, evaluation, and any possible combination of individual methods.

Tasks of Development

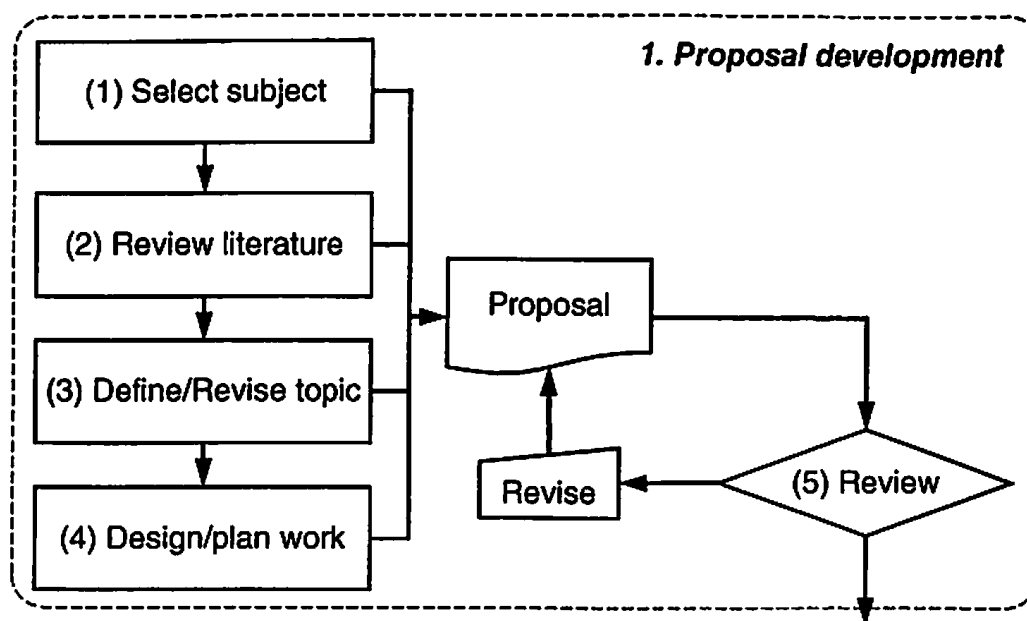


Figure 2.8 Research proposal development steps.

#1 Subject Selection

We may select a research subject from the following:

- Existing topics with advance potentials
- Continuation of previous work
- Exploring a new technology or subject
- Suggested or assigned needs

#2 Literature Review

a literature review is the next task after we choose a research subject. This task and its outcomes serve as a solid foundation to support and justify our new research objectives.

We need to answer two key questions from a literature review:

- Status: What are the current limits of knowledge of the particular subject?
- Value: What can the proposed research contribute to extending the limits?

#3 Topic and Objective Definition

A research topic is a specific task within a selected subject. A topic often plays the decisive role in many aspects of a research project, such as objectives, method, and anticipated results. Once the topic of a research project is decided, the data, methods, and overall project design can be planned accordingly.

#4 Work Planning

To develop a plan to accomplish research tasks, the proposed work should be broken into meaningful and manageable subtasks. A best way to illustrate a research plan is through a Gantt chart, which identifies the tasks and displays

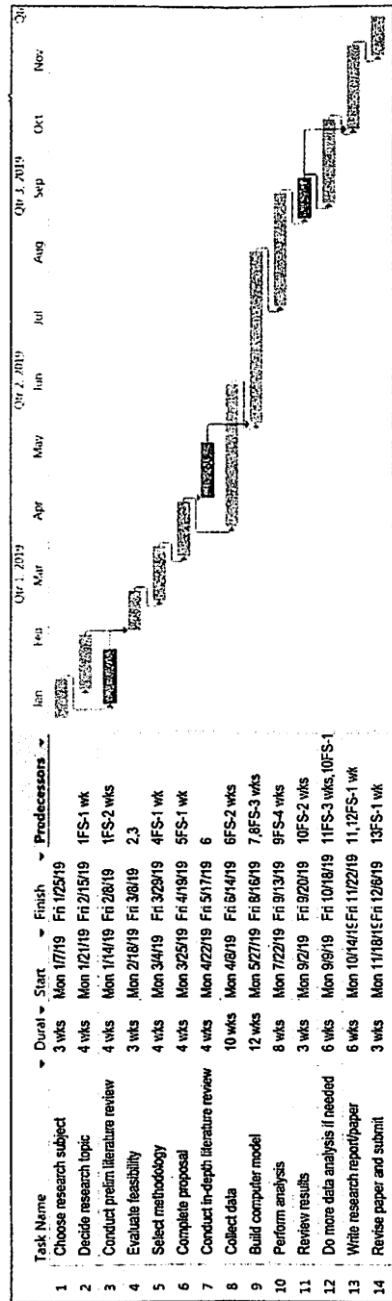


Figure 2.9 An example of research project timeframe.

their start and completion times in a specific order. In addition, a Gantt chart can demonstrate dependency of tasks and the critical path of a research plan.

Questions of Proposal Preparation

Section	Type	Sample question	Innovative	Feasible	Impactful
Objective (problem statement)	What	What to do?	✓	✓	✓
Description (background and justification)	Why	Why so important?	✓		✓
Background (literature review)	What	What foundation and new?	✓		
Methodology (strategy, methods, procedure, and resources)	How	How to do the work?	✓	✓	✓
Data (availability and process)	Where	Where/How to get data?		✓	
Work plan (tasks and timeline)	When	When to complete?		✓	
Anticipated outcomes (products, limitations, etc.)	What	What results and impact?	✓	✓	✓

4. Evaluation and RevisionAn Example of Evaluation Criteria

1. Significance – a compelling case for the potential contribution to solving a problem
2. Research Plan – appropriate for answering research questions or testing hypotheses
3. Personnel – PI and key personnel possess training and experience and commit sufficient time to competently implement research
4. Resources – Having facilities, equipment, supplies, and other resources required to support

A Simple Evaluation

We may consider the product of the two ratings as an indicator of overall proposal quality, that is,

$$\text{Proposal Quality Indicator} = \text{Feasibility} \times \text{Innovation}$$

Checklist**Table 2.4** A checklist of proposal peer- and self-assessment.

Item	VG	Good	Fair
Overall impression			
Informative and impressive title and abstract			
Clear overall picture, concise, and logical			
Technical merits to a professional field			
Feasible with manageable ambition and risks			
Modest level of confidence (tone in writing)			
Appropriate format and readability			
Objective and problem			
Well-defined, focused research problem			
Realistic and practical objectives			
Justified significance of a research problem			
Defined hypothesis if applicable and proper assumptions			
Based on the latest advance (adequate literature review)			
Methodology and design			
Proper methods to the problem			
Data plan (accessibility; permission if applicable)			
Right timeframe and project management			
Experiment plan (equipment, prelim results, etc.)			
Appropriate analysis method and computer software			
Compliance and IP/dissemination plan			
Possible issues/limitations addressed (contingency plan)			
PI and team			
Sufficient credentials of education and skills			
Good previous accomplishments and publications			
Appropriate time to devote to the project tasks			
Task and teamwork arrangement			
Career development if applicable			
Resources and budget			
Good institutional setting, facilities, and equipment			
Sufficient support staff and other (in-kind) resources			
Reasonable and justified budget estimation			
All budget items allowable			

A 3-D Evaluation View

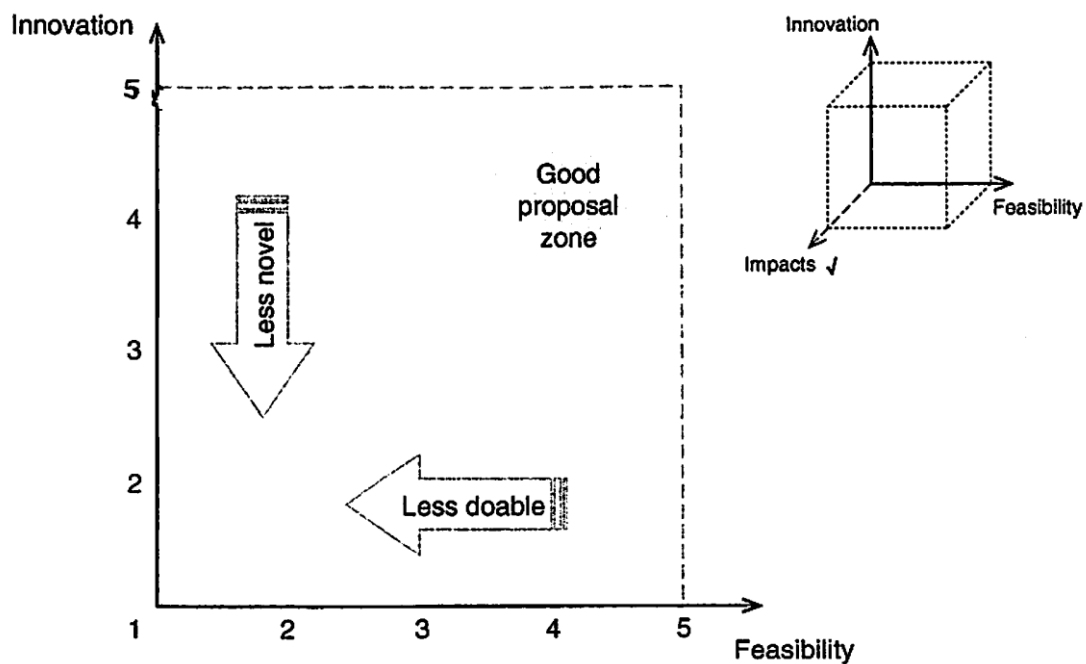


Figure 2.12 An overall evaluation of research proposal.

3. Summary

Research Initiation

1. A research proposal is a formal document, consisting of research objective, idea, and plan.
2. When developing a new research idea, we need to know what type of research the idea is line with.
3. The three indispensable cornerstones for a good research proposal are innovation, feasibility, and impacts.
4. Research proposal development is a structured process with multiple steps and considerations.
5. The terms of research proposal, protocol, and prospectus are often used interchangeably.
6. The objective of research, sometimes in the format of a hypothesis, is fundamentally important.

Composition of Proposal

7. The key elements of a formal research proposal include summary, project description, budget, researcher credentials, etc.
8. The objective of research should be stated clearly and concisely at the beginning of a proposal.
9. The project description of research should provide information on the overview, background, plan, methods to use, and outcome expectations of the research.
10. Research costs include multiple categories: activity cost, personal compensation, IDC, and miscellaneous.
11. A formal research proposal includes supporting materials, such as data management plan, references cited, cost-sharing arrangement, and appendices if applicable.

Proposal Development

12. Research funding agencies have their own specific requirements. A proposal must fully meet these requirements.
13. The anticipated outcomes must be consistent with the objectives.
14. Methods to be used confirm the researcher's capability and technical path to realize the vision.
15. The main steps of a proposal development include subject selection, literature review, objective definition, work plan, and so on.
16. The criteria of proposal evaluations vary in funding agencies but are primarily orientated on the three cornerstones: innovation, feasibility, and impact.

Evaluation and Revision

17. After drafting, a proposal may need four to six revisions. Each revision may have its own focus.
18. Research funding agencies have rigorous review and evaluation processes.
19. In proposal development, two key factors should be central: innovation and feasibility.
20. Self-assessment and peer review (checklist) are effective tools for proposal improvement.

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