Academic Research
a Guide for the Perplexed

Lucia Rapanotti and Jon Hall

Branch: For-restructuring
Hash: 533806945ef650f62829e669038ba4b8c9f141e2

Contents

Foreword

You have just about embarked in your very first Masters research project. That's both exciting and daunting.

Exciting because you will be able to focus on a topic of your own choice and to investigate in depth an issue or problem which is of particular interest to you, either personally or professionally. In doing so, you will acquire a deep knowledge of that topic, conduct a unique and novel research study, and develop and apply a wide range of research skills.

Daunting because your success will depend on you demonstrating your mastering of the topic and of the research process, that you can exercise competently a wide range of research skills, and can communicate your work effectively through an academic dissertation, possibly the largest and most demanding piece of writing you will ever undertake.

The aim of this handbook is to support you in taking your first steps into academic research at Masters level. It will provide you with a solid scaffolding for you to become a competent and confident researcher. It will demystify the language around academic research and, through practical advice and activities, will help you plan, manage and execute your project work successfully from start to finish.

But the benefits don't stop with the completion of your Masters project. In succeeding in your research project, you will have also gained and demonstrated a wide range of skills which are professionally relevant and valued by employers, from problem solving to effective communication, digital and information literacy, self-management and resilience. These transferable skills will serve you well in your profession and your life, regardless of the path you will take after your Masters course.

How to use this book

Content here; should also cover how much time studying the book may take stage by stage (although this may go into each stage table?)

Stage I

The Research

By now you will have some mastery of the techniques and tools that you need to *do* research at masters level. You may also have ideas about what you still need to do in the next step•.

With the skills you have so far gained, you're developing into an independent researcher• and you may feel that this book holds nothing more for you.

Stay with us a little longer though: the next sections aren't as long as those that you've studied already – you'll be doing more yourself, honing the skills you've picked up as you go along – but they might help to keep you systematic and on the path to submission.

You won't be surprised to know that stage 3 comes next; there's another research increment coming.

In Stage 3 you will focus on adding detail to both your aim and objectives and your research design. Stage 3 assumes that you have completed your Stage 2 work, and possibly discussed it with your supervisor•, particularly your research design choices.

With reference to our 5-stage framework, the activities which are in focus in Stage 3 are recalled in Table **??**, which also provides some guidelines for your interaction with your supervisor during this stage.

• If not, don't worry – we've got you covered with this chapter!

• Being an independent researcher isn't one of the examined outcomes of masters research, but if you're feeling confident in your research that's a good thing.

LR: update at the end

LR: to check all activity titles at the end

• If your proposal still requires some 'remedial' work to fully satisfy your course requirements then you should carry that out before moving on.

Table 0.1: Stage 3 Research Activities (15% of project length)

Deliverable	**Writing Outcome: by the end of this stage you will**	**Effort**	**Supervisor Interaction**
Identifying the research problem			
Adjust, if needed		2%	
Reviewing the literature			
Adjust, if needed		3%	
Setting research aim and objectives			

Continued on next page

Table 0.1: Stage 3 Research Activities (15% of project length) (Continued)

Deliverable	Writing Outcome: by the end of this stage you will	Effort Supervisor Interaction
finalise aim and objectives, and define tasks and deliverables	10%	Suitability of tasks and deliverables from objectives
Choosing the research design		
Complete research design, with detailed consideration of data and evidence, research strategy, research methods and procedures	20%	Suitability of research procedures
Gathering and analysing evidence		
Conduct pilot work to test aspects of your research design	35%	Scope of your pilot work
Interpreting and evaluating findings		

Continued on next page

Table 0.1: Stage 3 Research Activities (15% of project length) (Continued)

Deliverable	Writing Outcome: by the end of this stage you will	Effort Supervisor Interaction
n/a	0%	
Reporting, critical reflection and conclusions		
Assess research progress and write up Stage 3 report	25%	Any further improvements required
Work planning and risk management		
At stage start, review work from previous stage and project risk; adjust plan as needed If you have received feedback from supervisor on your previous stage work, adjust plan to include any revision recommended	5%	Any major adjustment required

Activity: Understanding the effort needed in this stage #1

Consider Table **??** carefully, taking notice of the entries in the 'Effort within stage' column. Write down the most time-consuming activities in this stage and what is expected under each.

Discussion

Developing your research design further and conducting your pilot work will constitute your major effort in this stage (55% of the study time in total): your pilot work will be an initial test of some aspects of your research design, including a proof-of-concept application of some of your chosen methods.

Chapter 1

Defending your claim of new knowledge

Being able to assert that you have made a contribution to knowledge is the point of structuring your research through a well thought-out research strategy – hence, the importance of methodology in research.

Choosing a good strategy is only the starting point, however. Having made your claim to knowledge at the end of your project, you still need to defend it in your dissertation. That means considering, essentially, everything that could have gone wrong – any weakness – with the execution of your research strategy, and explaining how you've dealt with it.

Introducing potential research weaknesses upfront and ways to deal with them is the purpose of this section: with this information, you can then be more mindful in the choice and execution of your own research strategy.

Figure 1.1 illustrates the point we are making. At its core is your claimed knowledge contribution at end of your project. Its defence is what you need to argue in your dissertation. Such a defence has to withstand external scrutiny, say that of your examiner or the wider community of scholars, researchers or practitioners your work is intended for. You claim to knowledge is subject to a number of weaknesses (four main types are considered in this section, illustrated as potential 'cracks' in your defence), and should you recognise any of them in your research, then your defence should explain how they've been dealt with (illustrated as bandaids over the cracks). The kind of 'bandaid' will depend on what you decided to do, one of addressing, avoiding, deferring or ignoring the weakness. If you choose to address it, then some specific kinds of bandaid are available to you: the ones we consider in this section are triangulation, reflexivity and critical review.

figure to re-draw

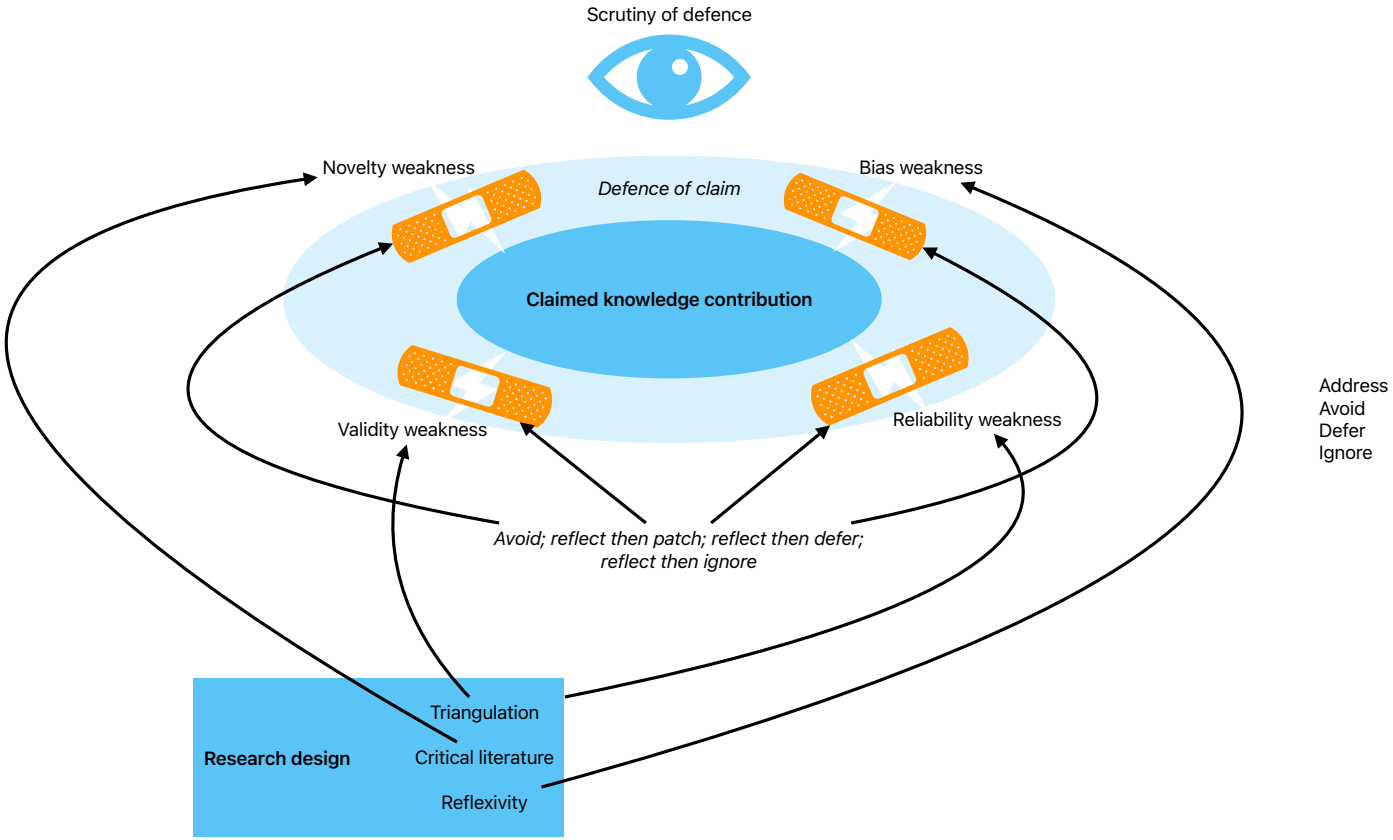

Figure 1.1: Research vulnerabilities

1.1 Weaknesses and ways to deal with them

We can class weaknesses in claimed knowledge contribution (see figure 1.1) as follows:

- validity weaknesses, i.e., the claim you have made to new knowledge isn't sufficiently credible, trustworthy, or accurate to be considered knowledge, or can't be generalised or transferred beyond your study
- reliability weaknesses, i.e., the procedures that you have used to establish your claim of new knowledge are not dependable, cannot be replicated under the same conditions or are not sufficiently repeatable in other contexts, or the descriptions and interpretations provided are incoherent or inadequate
- bias weaknesses, i.e., the claim you have made to new knowledge has been affected by your implicit or explicit cognitive biases, or bias affecting human participants in your study, making the new knowledge invalid
- novelty weaknesses, i.e., the hole in the literature that you claimed existed doesn't actually exist. If there is no hole, then you cannot have contributed new knowledge — perhaps you missed some key papers in your literature review or, perhaps in the time that you've taken to complete your research, someone else has made a similar contribution to knowledge as that you claim. Alternatively, while a hole may exist, the novelty of your claim may be in doubt — perhaps your research was not able to achieve all that you were hoping for.

There are, of course, connections between these types of weakness. In particular, if your research methods are not reliable, then any resulting claim to knowledge is unlikely to be valid. For instance, if the scale you use to measure the weight of an object returns different values every time (it's unreliable), then you can't draw a valid conclusion on the weight of that object. However, reliability is not sufficient for validity. For example, your scale may reliably return the same weight every time, but may overestimates it: in this case, while your scale is reliable, it is inaccurate, so that you still can't draw a valid conclusion on the weight of the object (unless you know precisely by how much your scale overestimates weights). Bias also affects validity. For instance, you may have a preconception of what the outcome of your research should be, so you discard any evidence to the contrary and only retain evidence that confirms your bias. In this case, your conclusions are untrustworthy, hence invalid. It is therefore essential to consider the weaknesses that may affect your research and take action to ensure they will not impact the validity of your claim.

As you will see in the next section, different research strategies are affected differently by these weaknesses. For instance, research based on quantitative objective measurements will focus more on ensuring reliability than research based on subjective interpretations of qualitative information, where the researcher's bias is more likely to have a negative impact.

In general, the possible actions you can take to deal with potential weaknesses fall into three options[•]:

- avoid the weakness, i.e., choose a research strategy which is not troubled by the weakness. Part of the justification for the choice of research strategy can then be a discussion, if necessary, that the weakness doesn't arise.
- address the weakness, i.e., be aware of the weakness during the research and put in place further strengthening research. This might be, for instance, a second of further iteration of the research strategy which addresses discovered weaknesses in earlier research. This would be reported as part of the research design.
- acknowledge and defer[•], most usually at the end of the research period when the research is complete, i.e., write a reflection on the effect the weakness had on the outcomes and commit to addressing that weakness in future research. This would be reported as part of your "Discussion" and "Conclusion and future work" chapters.

[•] There is actually a fourth way, which is to be aware of the weakness but to ignore it. We do not recommend this as your examiner of your dissertation is likely to have detailed understanding of the research strategy you have chosen, including its potential weaknesses, and is likely to pick any methodological omissions up.

[•] Although it may seem to have similar outcomes, this is a much better strategy than simply ignoring the weakness as, although you don't address it, you make the examiner aware that you are aware of it. It can also give you a very neat way of filling out your future work.

If you can't avoid a weakness and you can't defer it, you have to address it. Addressing it means that your examiner will have their questions answered about the weaknesses they know occur in the type of research you're doing. Their evaluation will be through the questions they ask of your research and you must be prepared to answer them.

1.1.1 Where to defend your claim

In your defence of claimed knowledge contribution, you should consider all potential weaknesses in turn – ignoring them leaves yourself open to a negative outcome of expert scrutiny. For each, you should make arguments as to why your claim doesn't suffer from it, or if it does to some extent, that you have dealt with it in a way that ensures there is still a contribution to knowledge arising from your research.

Typically, there are two places at which weaknesses in your claimed knowledge contribution should be discussed:

- in your dissertation, in all cases

- in any *viva voce* associated with your research course•

In general, an examiner will explore such weaknesses through a number of questions they ask of your dissertation. For each research strategy, many of these questions• can be predicted with reference to the types of weaknesses we have discussed above. Somewhere in your dissertation, then, you will need to expose your research strategy weaknesses and argue how your research has addressed them.

Here is an example paragraph taken from an actual dissertation (**miles2019dispelling**) with our commentary on specific points to the right, in the margin:

> My observational study focuses solely• on the external elements of the embouchure and what can be seen in real time with the human eye•, through the recording of video images. My analysis, and the conclusions that come from it, has been made from a purely visual perspective, captured by combinations of camera angles, without needing the use of any complex and expensive technologies•. In embarking on this research project, the initial intention was to measure facial muscle activity using Electromyography. This method proved to be too costly• and the heavily mathematic and science based analysis process, out of the current skill set of this researcher•. Furthermore, due to the significant evidence found in the literature regarding the internal embouchure, the concept of the tongue being a pivotal element in facilitating pitch change has been accepted as fact and deemed unnecessary for further study in this project[8]. Therefore the ultimate goal of my research is to inform the teaching and learning of brass wind performance, with particular reference to the role of the embouchure[9]. With this in mind, it is therefore important that the data obtained through this study be identifiable through the simplest means possible, so that it can be of the most benefit to the brass-playing community[10].

• As not all masters research have an associated *viva voce*, weaknesses should always be addressed in the dissertation itself. Even if your course does have a *viva voce*, it can be a nerve-racking experience to be confronted by an examiner asking questions to which you have no answer because you haven't thought about it!

• If not all; although examiners will have their own way of asking them!

• Being specific on which phenomena are studied...

• ...and on the observations made of them...

• ...thus correcting any expectations of what might have been achieved...

• ...contextual factors prevented more sophisticated observations...

• ...and initial investigations reveals how difficult this would be

[8] There was no knowledge contribution to be made in this particular area...

[9] ...and so the knowledge contribution was ...

[10] ...and our research goals were set accordingly.

Activity: Which weaknesses are discussed? #2

Consider the extract above alongside our comments. Which kinds of weakness does it refer to? How were they dealt with? Which other weaknesses could have been discussed?

Discussion

We found two potential weaknesses which were considered and addressed:

- novelty: by being specific on the phenomena studied (the external elements of the embouchure), the text clarifies where the claimed novelty of the research lies. This makes it easy to check against related work in the literature, something the text could have mentioned explicitly
- validity: the observation of such phenomena through video images is defended as a valid method in relation to the aim of devising a practical approach to inform teaching and learning. This is in contrast to more sophisticated, but costly, approaches that would have been possible, but deemed unnecessary for the aim of the research.

Other potential weaknesses not discussed are:

- reliability: how reliable were the observations? Would another researcher have reached similar conclusions?
- validity: the study assumes the embouchure is a key factor in the teaching and learning of a brass instrument. Where does this assumption come from?

As this is only a brief extract, it is possible, of course, that these weaknesses were considered and dealt somewhere else in the dissertation.

1.2 Approaches to address weaknesses

In this section, we consider three common approaches used to address weaknesses in research.

1.2.1 Triangulation

Triangulation **mathison1988triangulate** consists of using multiple data sources and methods, or even multiple researchers, to develop a comprehensive understanding of a phenomena under study and arrive at a particular conclusion about that phenomenon. Triangulation was introduced in the social sciences in the mid 1950s **campbell1959convergent**, and since has become an accepted approach across all disciplines, regardless of research paradigm.

The core idea behind triangulation is that if different data and methods converge towards the same conclusion, then it is more likely that such a conclusion is valid, that rival explanations can be dismissed, that the different procedures followed are reliable, and that the effect of any bias is mitigated. In this way, triangulation makes your research more credible, and your claim more defensible.

However, because triangulation applies many techniques or derives conclusions from many sources, it can result in inconsistent or contradictory findings. So, it is important to understand that triangulation does not necessarily guarantee convergence on a single proposition about a phenomenon. Instead, it provides a rich and complex picture that requires careful interpretation and explanation by the researcher. As a result, triangulation should be used cautiously and researchers should be prepared to explain and make sense of the various outcomes it may produce. Triangulation also adds complexity and requires more time and effort that must be accounted for.

Main kinds of triangulation include **denzin1978research**; **patton1999enhancing**:

Data source triangulation refers simply to using several data sources. These may be the inclusion of multiple participants to interview, or the consideration of a particular phenomenon under different conditions in space and time. For example, in an educational setting, you may wish to measure the efficacy of an educational programme on different student cohorts, possibly over different academic years, or delivered by different educators. With data triangulation you increase the validity of your claim across different contexts, so that your results are more generalisable.

Investigator triangulation involves several researchers collecting and analysing data[•]. For instance, you may have different researchers repeating measurements using the same lab equipment and procedures. The involvement of different researchers who independently apply the same techniques to arrive at the same conclusions, increases both reliability and validity of those outcomes, and mitigates against each researcher's bias. This is particularly important in qualitative research where data are often interpreted rather than measured precisely.

• Because there is more than one researcher involved, it is unlikely that you will be required to perform this form of triangulation in your Masters project. You may, however, be a researcher in the triangulation of another's researcher – your supervisor, for instance – which means that you should be prepared to be involved. Be sure to schedule some time with your supervisor to discuss their needs, should this be the case.

Methodological triangulation refers to the use of multiple methods in the examination of a phenomenon•. For instance, a neuropsychologist may combine direct observation of human behaviour with neurological data from brain scans to obtain a comprehensive picture of what motivates people to make certain choices. Methodological triangulation allows strengths and weaknesses of different methods to compensate for each other, increasing both reliability and validity. However, it may be difficult to combine results from different methods because of their differing ontological and epistemic stance.

• We deal with mixed method research later in this Stage.

Theory triangulation refers to the use of different theories or hypotheses to analyse data and interpret phenomena. For instance different motivation theories could be used to study resistance to change in organisations. By employing several theories, findings can be considered from different angles, compensating for possible limitations or biases of each individual theory.

Activity: Distinguishing different kinds of triangulation #3

Consider each of the following examples and indicate which kind of triangulation they represent:

- research on student experience in a university looking at student survey data and students' study results
- research on study practice and academic performance, combining an online survey and interviews with a selected number of participants
- research on sleeping patterns of the elderly, using data from care homes in the UK
- research on volcanos asking vulcanologists around the world to contribute seismological measurements over a period of time.

Discussion

These are example of, respectively:

- data triangulation, in which two different kinds of data are considered
- methodological triangulation, in which two different methods are applied
- data triangulation, in which similar data from different locations are considered

- investigator triangulation, in which several researchers are invited to collect and contribute data. Presumably, this also encompasses some data triangulation in the sense that similar data from different locations around the world are collected and analysed.

1.2.2 Reflexivity

According to **jamieson2023reflexivity**:

> Reflexivity is the act of examining one's own assumption, belief, and judgement systems, and thinking carefully and critically about how these influence the research process. The practice of reflexivity confronts and questions who we are as researchers and how this guides our work.

So, reflexivity admits that the researcher isn't an objective, unbiased observer of truth, but someone whose worldviews and subjectivity influences every step of the research process. Through reflexive practice, the researcher can then engage in a more honest and transparent research process, increasing research reliability and mitigating bias.

Note that there is a difference between reflection and reflexivity. Reflection is usually done retrospectively: you could reflect on something that has happened during your study to identify important lessons for the future. In contrast, reflexivity takes place throughout the research process — before, during and after, hence has the potential to shape it. Also reflection focuses on things you have done, while reflexivity explores motivations — your assumptions, beliefs, biases, etc., behind those actions.

Reflexivity is relevant and applicable to all types of research. Qualitative research has the longest tradition of reflexivity, with qualitative researchers encouraged to examine and openly acknowledge their own beliefs and biases, and their impact on the research. In quantitative research, the acceptance of the importance of reflexivity is growing, and goes alongside an acknowledgement that there are limitations and biases in the scientific method too, so that quantitative research is not a 'gold standard' of objectivity.

Reflexivity should be embedded in all steps of the research process. In the early stages, it can apply to the choice of research problem or questions, by guiding the researcher to consider explicitly subjective factors which may explain why that particular choice was made and why the researcher is best placed to research it. In data generation, reflexivity can expose biases and unchecked assumptions which may

affect how samples and data sources are selected or participants are recruited. In data analysis and their interpretation, reflexivity may lead to uncover reasons why certain evidence is given more weight or meaning, while other is discarded, for instance due to confirmation bias. In formulating conclusions, reflexivity can support "thinking about thinking"•: the process of questioning the way we think to assess how valid and reliable our conclusions are. This is particularly important because while the human brain has the potential for logic and critical thinking, these are not innate skills: rather they need developing, akin to the skills that one must develop to become, say, a proficient musician or mathematician. Psychologists have uncovered that left untrained, our brain tends to make mistakes, which stem from a variety of factors•, including errors in perceptions, flawed memories, heuristic thinking, logical fallacies and cognitive bias. Reflexivity can help us become aware of these tendencies.

• So-called 'meta-cognition'

• A fascinating series of lectures on this topic is "Your Deceptive Mind: A Scientific Guide to Critical Thinking Skills" by Steven Novella.

Activity: Reflexivity practices #4

Conduct a web search on reflexivity practices adopted by researchers. Briefly summarise what they are, and how they are useful. Comment on which of such practices you could adopt in your work.

Discussion

You may have found some or all of the following:

- Reflexive writing, such as research journals, diaries, fields notes and memos. These are common tools used by the reflexive researcher at any point in the research process to record assumptions, experiences, observations, perceptions, procedures, and decision points. They are used to bring into focus the researcher's intention and gaps in their knowledge or thinking, as well as interpersonal dynamics, including power ones.
- Positionality statement. This is a kind of reflexive writing aimed at describing a KES: Book Scheduled: 5 Jun 2024 at 09:30 to 12:00, BST researcher's characteristics (such as age, social class, race, etc.) and beliefs (such as political, philosophical, etc.) which may influence the research.
- Narrative autobiography. This is also a kind of reflexive writing focussed on the researcher's life experiences and motivations which may influence the research, particularly the researcher's interaction with participants and understanding of participants' accounts. The aim is to better prepare the researcher for their interaction with participants, so it is best conducted when planning data collection/generation.

- Reader-response exercise. This addresses how the researcher's own assumptions and experiences may affect their interpretation of participants' accounts. It consists of including a layer of codes to indicate how the researcher reacts to and interprets participants' accounts in relation to their own background and personal history. As such, this practice is useful during data analysis and interpretation.
- Collaborative reflexivity. This entails engaging in reflexivity as part of a research team, with collaborators questioning assumptions and decisions. It assumes mutual trust, and a commitment to ethics and rigorous research, regardless of seniority or status. It applies to all stages of the research process.

1.2.3 Returning to the literature

Addressing novelty weaknesses means returning to your literature review as your research progresses and understanding increases to cast an increasingly critical eye over it, and possibly widen its scope to further related work which may have been published more recently. Each source should be reconsidered for what you thought it originally said and what you now think it says, using any difference• to drive further reflection on your findings, methods, data generation, or even research problem. This process will help you both ensure there continues to be a gap your research can contribute to, and assess the extent of the novel contribution your research can make in relation to related work which has already been published.

• In the best case, there will, of course, be no difference!

As in the example we included at the end of Section 1.1.1, while defending your claim or explaining your research design, your reader can be made aware of this process and how it has altered your research. Deepening the critical nature of your literature review allows your reader to understand that you are a reflective researcher and can turn any novelty weakness into a research strength!

Chapter 2

Your research strategy candidate list

While your own research strategy will be specific and unique to your project in the way it informs the research you will conduct, standard research strategies have emerged over time, influenced by research paradigms and research practice within specific disciplines. Each of them can be seen as a sort of 'recipe' which summarises common ways to conduct academic research: by adopting or combining some of these strategies, you can come up with your own specific instance for your project.

There are many standard research strategies in the literature, often with many variants: the 12 strategies we consider in this book are discussed in this section. The outcome of working through this section should be your choice of a candidate research strategy that:

- is a good fit for your research problem, i.e., that will allow you to develop a contribution to knowledge arising from your research problem
- makes the most of your current research skills and resources, i.e., the background knowledge and skills you bring to the research, the time that is available to you, and it fits with your research context.
- can be evaluated through a list of questions that could be asked of it by a knowledgeable evaluator, such as an examiner.

From the first two of these, you will gain an understanding of which steps you will be required to take to generate, analyse and interpret research data that, when complete, will make your contribution to knowledge. From the third of these, you'll be able to structure your research report – your dissertation – by describing your answers to the evaluative questions.

Table 2.1: Research strategy choice

Research Strategy candidate	Considered	Excluded	Reason excluded
Survey	☐	☐	
Design and Creation	☐	☐	
Experiment	☐	☐	
Case study	☐	☐	
Action research	☐	☐	
Ethnography	☐	☐	
Systematic research	☐	☐	
Grounded theory	☐	☐	
Phenomenology	☐	☐	
Simulation	☐	☐	
Mathematical and logical proof	☐	☐	
Mixed methods	☐	☐	

The 12 candidate research strategies we consider are listed in Table 2.1. For each, after a brief description explaining the focus of the strategy, we will:

compare to structure of each strategy section, at the end of editing

- describe what kind of knowledge contribution that can be made through it
- describe the ways in which data is generated and analysed within the strategy
- describe how a contribution to knowledge using the strategy will be evaluated
- ask “Is this strategy right for me?”
- provide a number of references that give more detail, if you are seriously considering the strategy

This is a lot to digest! Rather than going through all the information about each strategy in turn, we recommend you take the following steps to first reduce your list of candidate strategies from which to arrive at your chosen one.

Step 1 Consider a strategy, and read its description and type of knowledge contribution that can be made through it. Compare these with your research problem to check whether that research strategy should be a candidate for your project. When you have done this, you should check its tickbox in the first column of Table 2.1 – I've considered the strategy. If there's a clear mismatch with your research problem, you should check the tickbox in the second column – that the research strategy has been excluded – and give a reason why you have excluded it – say, the knowledge contribution it makes is not of the correct form – and you can move onto the next research strategy and repeat this step. The "Reason excluded" column will be used in the your dissertation to justify your choice of research strategy so think deeply about what you write here – you can use the text of the knowledge contribution and subsequent subsections to frame your reason for excluding it. Whatever you do, don't leave it blank!

Step 2 If you have not excluded the research strategy, then you should read further – next come the methods you would use to generate and analyse data. This gives you another reason to exclude a research strategy – that the data or participants your research needs are not accessible or the methods are not feasible within your project•. If this analysis leads you to exclude the research strategy, complete• the second tickbox column and record the reason, then move on to the next research strategy going back to Step 1.

Step 3 If you have not been able to exclude the research strategy, then you should read the "Evaluation" section•. These are questions you should be able to address once your research is completed, and which you should keep in mind from the very start. If you feel you are unlikely to be able to address them, then this gives you another reason to reject the strategy. Once again, if you have excluded the strategy, tick the box in column 2, record the reason in column 3, then move on to the next strategy and restart the process.

Step 4 If you have not been able to exclude the research strategy, it's time to look at "Is this strategy right for me" section. This lists a number of other things you should consider that might lead you to exclude it, particularly in relation to skills you may need, or other features of the strategy which may not align with what you can achieve within your project. If you came to reject the strategy, as before, tick the box in column 2, record the reason in column 3, then move on to the next strategy and restart the process. This section may include alternative strategies you could consider next, otherwise, just proceed through the list.

Step 5 If you have not been able to exclude the research strategy, then look at the "Further reading" section and record the suggested references in your bibliographical database. You will access these articles

- Of course, you will need to choose *one* research strategy, so be careful not to exclude something that, perhaps with some adjustment, can be made to work.
- This time, the reason will be something to do with data generation techniques not accessible.
- Perhaps taking notes on things you haven't immediately understood.

later on, to gain a deeper understanding of your candidate research strategies. You can now move on to the next strategy, and restart the process.

We have wrapped up this process in the following activity, which constitutes the most substantial practical work for you to carry on in this sub-section:

Activity: Arriving at your candidate strategy list #5

Copy Table 2.1 to your favourite word processor or spreadsheet application. Apply the process above until you have considered all the strategies, updating your table as you go along, and recording related references in your bibliographical database.

Guidance

The aim of this activity is to help you narrow down the possible choices of candidate strategy for your project, without having to dive deep into the detail of all 12 strategies presented. This is something you will do after you have completed this activity: the references recorded in your database will then provide a starting point for your review of methodology-related literature.

Once you have exhausted all the strategies, there are three possible outcomes:

- you find yourself with a single candidate research strategy, in which case you should go for it!
- you find yourself with a number of candidate research strategies, in which case you need to study more in order to make a choice. You may also like to think about mixing up bits of each to give you your own mixed methods research strategy.
- you find yourself without a choice, in which case you've probably been too picky... and you should try again – you can't do research without a research strategy and you're unlikely to come up with one not on this list – a completely novel one.

In all cases, you should discuss the outcome with your supervisor:

Activity: Discussing your choice with your supervisor #6

Arrange a time to talk to your supervisor about the process you have followed to identify possible choices of research strategy for your project, and what the outcome was.

Guidance

As an expert in the research process and in your field of study, your supervisor will be able to advise on whether the choices you have made are appropriate, or even recommend strategies you should consider in details.

2.1 Survey research

Survey research focuses on collecting, in a standardised and systematic fashion, up-to-date, real-world data from a sample• of the population which is the focus of your research. Depending on the population and selected sample, large amounts of data may be collected.

• A sample is a subset of data from a population of interest. We will return to sampling in Stage 4.

2.1.1 Knowledge contribution

The contribution to knowledge of survey research is to uncover patterns that can be generalised from the sample to the target population.

A typical application of survey research is to predict the outcome of an upcoming election by polling data from a sample of voters.

2.1.2 Data generation and analysis

For your data generation, you need to identify upfront which data you will collect in a standardised matter, your target population and sample. The sample must be representative of the population in the sense that it should reflect accurately population characteristics.

Suggested by the name, a survey – a standardised set of questions administered to a number of respondents – allows the researcher to gather information about a population. Surveys can take many forms, from interviews to questionnaires to focus groups, but authors vary on what they consider appropriate•. They can be administered via the internet (more traditionally by mail), over the phone, or even face-to-face. Mixed-mode surveys combine these options into more complex instruments, perhaps using a broader but simpler questionnaire to identify potential participants for a deeper face-to-face interview to follow.

• Be sure to consider any supplied preparatory reading on the survey research strategy to ensure that you meet your supervisor's (or other's) expectations of what will be appropriate.

In your data analysis, you seek patterns in the sample data collected to arrive at generalisations to the wider population. Statistical analysis is usually applied, possibly complemented by some thematic analysis, if open-ended questions are also included to elicit qualitative data.

2.1.3 Evaluation

The following questions are typically asked of survey research:

1. Reliability:
   - Are the sampling frame[•] and sampling techniques[•] used adequately explained?
   - Are the data generation and analysis methods adequately described?
   - Do the survey questions allow for consistent and dependable measures by different respondents?
   - Are significant differences between respondents and non-respondents discussed?
2. Validity:
   - Is the sampling frame appropriate? Does it provide sufficient coverage of the target population in terms of its characteristics of interest?
   - Is the sample representative? [•]
   - Is the response rate adequate? How were non-respondents handled?
   - Do they survey questions allow to measure or assess all that is needed?
   - Has statistical, or other, analysis been appropriately applied?
   - Are generalisations made about the target population appropriate? What reasoning chains have led to such generalisations?
3. Bias:
   - Is the questionnaire designed as to avoid leading questions, which may have an unduly influence on the respondents?

• The sampling frame is the set of individual units of the population from which the sample is drawn. Such individual units may be participants or data points in a data set.

• We will look at sampling in Stage 4.

• This relates to the question of whether the sample is sufficiently large and/or as diverse as the population.

2.1.4 Is this strategy right for me?

This strategy sets certain requirements of the researcher for them to be successful. These include that:

1. you must have access to an appropriate population sample, so that a sufficient volume of data can be collected and deep analysis performed. If this is not possible, for instance, because you have limited access to the population, you might like to consider case study research instead.

2. the phenomena and characteristics of the population which are of interest should be measurable through questions asked through a survey. If this is not the case that then you're not going to be able to make a contribution to knowledge about those phenomena or characteristics, and you might like to consider phenomena that can be measured, or a different population for which those phenomena can be measured.

3. while this strategy may produce lots of data in a relatively short time, the depth in the data can sometimes be lacking, given the focus on what can be measured. If deeper or more nuanced data is needed, then you may like to consider case study research instead.

4. conducting a survey means that you'll be analysing phenomena using point data, i.e., data that were collected at a point in time – that time at which the survey was answered. If your research requires longitudinal data, i.e., data that could change over time, then survey research becomes more difficult as you might need two or more surveys to collect the changing data. While it's not impossible to do this, it adds many complications: earlier participants might not be available for later surveys, their mindsets might have changed in the intervening period, etc. If this is the case, then you should consider whether the choice of phenomena is appropriate. Alternatively, you might like to consider one of the experimental research strategies described below.

5. surveys are not suitable to investigate the mechanisms behind cause and effect relationships, for which you should use an experimental research strategy instead.

6. conclusions from survey research rely on the veracity of the responses received, something you can't necessarily take for granted. Even when there is no intention to deceive, people's answers may be inaccurate due to many factors, including a tendency to wishing to provide the 'right answers', that is what they may believe is expected, or poor recall of past events or of detailed observations they have made, or even lack of trust which may influence what they are willing to disclose. Triangulation,

therefore, may be required to increase validity, but this will add complexity to the strategy. If this is not possible, then other strategies may be advisable, for instance, participant observation through ethnographic research.

2.1.5 Further reading

To deepen your understanding of this strategy, you can start from **dillman2014internet**; **oates2008researching**; **johannesson2014research**; **kalaian2008encyclopedia**.

2.2 Design science research

The design science research strategy• focuses on developing novel solutions to problems, a problem being a need in context. The solution should be an artefact, by which is meant anything designed and constructed by humans: this is a very broad definition, encompassing all that does not exist in nature, including any artificial object, construct, process, policy, model, method, etc.

• AKA Design and creation strategy.

2.2.1 Knowledge contribution

The contribution to knowledge is that which can be learned from the design and creation of the artefact as the solution to a problem. Knowledge contributions therefore come from an exploration of the problem, of the artefact itself, and its design, development, use, or other characteristics of the real-world problem solving process – for instance, whether it is linear or iterative, or the ways in which problem and solution understanding and validation are conducted.

This strategy leads to tangible artefacts which fit real-world contexts, and is particularly suited to emerging and rapidly changing technology-related fields of study, where new problems emerge all the time and known solutions are sparse or become rapidly obsolete, hence necessitating continuous innovation. Lots of research in Computing is an expression of this strategy, for instance designing computational systems able to emulate human cognition, as is the case of AI•.

• Artificial Intelligence

2.2.2 Data generation and analysis

Data generation is through the problem-solving process of articulating the problem, and designing and constructing the solution artefact, with the interactions between actors (customers, clients, designers, others),

technologies and/or knowledge as the source of data. Modelling methods are widely applied, possibly informed by data generation methids, like reviewing existing documents or interviews with stakeholders and experts or observation of people's behaviour. Prototyping is often used to produce proof-of-concept artefacts to test, demonstrate and improve the design.

Data analysis focuses on knowledge generated in the evaluation of both problem and artefact, including solution characteristics in relation to the extent they address the problem – the identified need in context. Specific evaluation techniques will depend on the nature of the artefact, and may include problem owner•'s validation, various forms of testing, or end-users' evaluation and feedback.

• By problem owner we mean the person or people who have expressed the need to be addressed and are able to establish whether the solution has met it.

2.2.3 Evaluation

Evaluation of the design and creation research strategy typically consists of the following questions:

1. Novelty:
    - What is the novelty in the artefact, its design, development, and/or creation?
    - To which extent does the artefact address the problem? Have its efficacy and utility been demonstrated? What evidence is provided?
2. Reliability:
    - Are all stages of the problem solving process discussed, including interactions with stakeholders?
    - Are the ways data are generated and analysed, both in problem and solution space, adequately described?
3. Validity:
    - Are appropriate approaches applied in the design and creation of the artefact?
    - How is the artefact assessed? Are the assessment criteria appropriate and documented? How were they determined?
    - Which generalisations are made from the design and creation of the artefact? Are they appropriate?

2.2.4 Is this strategy right for me?

For this strategy to be successful:

1. There must be demonstrable novelty. You must be able to argue that your research does not focus on 'normal' design, that is you are not simply re-implementing a solution to a well-known problem through a well-known development process and well-practiced skills•. If you cannot clearly identify that novelty, then you will not be able to claim a contribution to knowledge.

2. There should be a problem owner which is separate from the researcher, and who sets the requirements and context for the artefact, with the researcher working on its development for that context to meet those requirements. If you do not have access to a real-world problem owner then this strategy is not applicable.

3. If the problem owner is, say, your employer or a business you are collaborating with, and for which addressing the problem is a matter of urgency, then you must establish whether it is feasible for you to deliver a novel solution in a timely fashion. Research always brings a level of uncertainly so that estimating time to success, or if success is even possible may not be easy. If you can't ensure feasibility within the timescale of your project, then you may need to rethink the problem to address.

• Learning new skills may be valuable from a personal perspective, but will not, by itself, make a contribution to knowledge – learning them means that they exist already!

2.2.5 Further reading

To deepen your understanding of this strategy, you can start from **oates2008researching**; **brocke2020introduction**.

2.3 Experimental research

Experimental research provides a controlled environment in which cause and effect relationships can be investigated, expressed as hypotheses•. The strength of an experiment is that it can reduce the influence of confounding factors on a cause-effect relationship.

The potential scope of application of the experimental research strategy is wide, ranging from scientific experiments under laboratory conditions controlled by the researcher to field experiments involving people in a real-world setting in which some factors may be outside the control of the researcher.

• A hypothesis is a tentative statement about the relationship between the phenomena to be tested in the experiment.

There are pros and cons of each. While laboratory experiments are very reliable due to the high level of control, they can be very artificial, with little or no relation to a real-world context. The opposite is true for field experiments.

2.3.1 Knowledge contribution

The experimental research strategy contributes to knowledge through allowing cause and effect relationships between real-world phenomena to be established.

For instance, you may run an experiment to test whether the use of mobile phones just before going to sleep disrupts people's sleeping patterns.

2.3.2 Data generation and analysis

The experimental research strategy revolves around making an intervention within tightly controlled parameters. Observations and measurements are made of before and after the intervention and a comparison is made. Any difference is assumed associated with the intervention made.

For instance, in establishing a causal relation between the use of mobile phones and sleeping patterns, we could investigate the effect of the blue light emitted by a mobile phone on reducing the production of melatonin: this is the hormone which controls a person's sleep-wake cycle, so that its reduction is likely to disrupt a person's sleeping pattern. We would then measure the amount of melatonin produced by the body (these are our measurements) with and without exposure to the blue light of a mobile phone (this is the intervention), then analyse any difference to establish whether a causal relation exists.

So, you generate data through observations and measurements under different experimental conditions, and analyse your experimental data to explain causal relationships between the factors under study.

Depending on the complexity of the relationship between cause and effect, more or less complex experimental designs can be used. Those involving an inaccessibly large population of individuals, as might be the case for a medical drug trial, use sophisticated techniques to choose representative samples, as well as sophisticated statistical analysis to test hypotheses.

However, even simpler "local" cause-effect hypotheses may rely on the availability of a fully equipped scientific laboratory to work.

2.3.3 Evaluation

Typical questions in the evaluation of the experimental research include:

1. Reliability:
   - Are the experimental variables manipulated or measured adequately described?
   - Is there a clear account of what is controlled?
   - What are the experimental procedures? Are they sufficiently detailed so that the experiment can be repeated by an independent third party?
   - In a social setting, what information is given about participants and how they were found?
   - What information is given about the apparatus and the process used to make measurements?
2. Validity:
   - Was a hypothesis or predicted outcome of the experiment clearly stated?
   - If a population sample was selected for the experiment, how representative is it? How was it selected? Which measures were taken to avoid sample bias•?
   - If statistical analysis is applied, how adequate is it? Have appropriate statistical tools been used and their use justified?
   - Are confounding factors or outliers identified and discussed?
   - Are the statistical and other analyses convincing of the conclusions?
   - Has the experiment being replicated?

• Sample bias occurs when some elements of the population are more likely to be selected than others.

2.3.4 Is this strategy right for me?

Although widely applicable, the experimental research strategy has some counter-indications:

1. when testable hypothesis cannot be formulated, concerning the cause-and-effect relationships of interest
2. when the cause/effect relationship is very complex, for instance, depending on many factors, which cannot be accounted for in an experiment

3. when confounding factors and variables cannot be isolated, or no level of control is possible
4. when the experiment is a one-off and cannot be repeated
5. if you don't have access to specialised equipment required
6. if you don't have (or can't develop) statistical analysis skills required

2.3.5 Further reading

To deepen your understanding of this strategy, you can start from **oates2008researching**; **johannesson2014research**; **field2002design**.

2.4 Case study research

Case study research proceeds through the in-depth study of a notable instance of a phenomenon within its real-world context, particularly when it not possible to separate the phenomenon from that context. The study of a single phenomenon requires the researcher to delve deeply into the context of that phenomenon, whether that be a project, an organisation, an engineered system, a policy, an economic or historical setting, or other. Case studies allow the researcher to study complex phenomena where several factors are at play, and to explore alternative meanings and explanations.

2.4.1 Knowledge contribution

Case studies focus on the 'how?' and 'why?', so that the knowledge contribution is a detailed insightful account of the phenomenon in its natural context, including when appropriate its relationships with other phenomena, and relevant processes and causal chains.

What you seek with a case study can span from exploring possible questions or hypotheses for follow-up research, to explaining why certain outcomes have occurred, to investigate changes over time. For instance, an example of case study could be a detailed investigation of the US Equifax social security breach of 2017, in which 143 million of their consumer records were stolen by hackers. This may be descriptive of the chain of events that took place or explicative of why things happened the way they did, or both.

Therefore, case studies come in many forms, including:

- exploratory: in which the researcher explores a research problem sufficiently to be able to conduct a further study. If you're considering studying for a PhD after your Masters research, then this might provide a head-start for your future research
- multiple: in which two or more instances of the phenomenon are chosen, which present both similarities and differences, to provide an even richer analysis of the phenomenon in its context
- longitudinal: in which the researcher considers the state of a phenomenon over time. This offers a natural storytelling context in which change in the phenomenon and/or its context can be analysed.

Combinations of the above are also often adopted, allowing even deeper exploration of both relationships between phenomena and how they develop over time or in response to contextual factors.

2.4.2 Data collection and analysis

Case studies require you to collect empirical data from a great variety of sources, and to focus on depth rather than breadth. Therefore, all data collection techniques which allow you to do so may be used, from observation of the phenomena *in situ* and the context and processes in which it participates, to surveys of those that experience the phenomena in context (through interviews, questionnaires, *etc.*), allowing for multiple stakeholder views to be taken into account, to studying forensically existing documents that directly or indirectly describe the phenomena. This will lead to much data to be collected — mainly qualitative, but also quantitative to some extent, so that their analysis can be very rich and complex.

2.4.3 Evaluation

An experienced researcher evaluating case study research will ask the following questions:

1. Reliability:
    - Has the type of case study conducted been clearly described and justified?
    - How were ethical considerations taken into account, particularly in relation to participants and confidential information handled?
    - Were the data generation and analysis methods adequately described?

- Are the procedures followed appropriately documented?

2. Validity:

   - Have the criteria for choosing the particular case study been described and justified? Is the choice appropriate for the phenomenon studied?
   - Did the data generation methods generate the right type of data about the phenomenon in sufficient depth and quantity?
   - How was a detailed investigation of the phenomena conducted? Was the researcher able to work within the case study context?
   - Does the research adequately describe the relationships between phenomena and the processes in which the phenomena participate?
   - Is the data analysis systematic and transparent? Are the steps taken to arrive at conclusions clearly explained?
   - What generalisations were made from the case study research? Are they appropriate for the phenomenon and its context?

2.4.4 Is this strategy right for me?

There are conditions for this strategy to be successful:

1. Case study research requires you to have access the phenomenon in its context to be able study it holistically and generate rich, detailed descriptions. As an example, if you're not a teacher, it might be difficult to gain access to a classroom to study student/teacher interactions. If access is an issue, then you should consider a different strategy, like systematic research reviews, which work from secondary sources.

2. Access to data sources, such as policy, processes or procedures within an organisation, may rely upon interaction with others. Even if you already have a good relationship with them they might not have the time to assist you sufficiently for your data generation to be successful within the timeline of your project. If time is an issue you should consider alternative sources, or even a different research strategy.

3. Being embedded within the context of the phenomenon, as might be the case, for instance, of an employee of an organisation, facilitates the investigation of the phenomenon. In this case, however, alternative research strategies are also applicable, such as ethnography or action research.

4. You must have the required knowledge to understand the phenomena under study. For instance studying the processes by which an engine controller in an aircraft is designed may require a detailed understanding of technical documentation, language and even mathematical or computational theories. Acquiring this knowledge from zero as part of your research may not be possible or may consume too much time•. In such cases you should reconsider the phenomenon to study.

5. You need to make a judicious choice of case study to be able to make any generalisations about the phenomenon beyond the particular instance. If you don't have access to a significant instance of the phenomenon and generalisation is an important consideration, then you should consider a different research strategy.

• The success of your research will depend critically on climbing any learning curve quickly and successfully, even if that learning curve looks like El Capitan!

2.4.5 Further reading

To deepen your understanding of this strategy, you can start from **yin2009case**; **oates2008researching**.

2.5 Action research

Action research focuses on real-world situations for which improvement is sought through participatory and collaborative research. Its focus is on practice change, and continuous learning and improvement via an iterative 'plan-act-reflect' cycle which generates both knowledge and action.

2.5.1 Knowledge contribution

Action research should make both a contribution to knowledge *and* to practice: an action researcher strives to generate knowledge and action to address important problems that people experience in their practices, so that the knowledge contributed originates in real-world needs. The researcher is an active participant in the research, rather than solely an observer, alongside other collaborating practitioners: in fact, collaboration and reflexivity are essential elements of this strategy.

The outcomes of action research may be new theories or methods alongside their direct implementation to improve practice within a specific professional or social setting. For example, in an educational setting, where this strategy is widely applied, a group of teachers may come together to study the composition and effectiveness of homework at each school grade, with a view to improve the balance between knowledge-based and practice-based learning.

2.5.2 Data generation and analysis

Similar to case studies, action research requires you, and your collaborators, to collect empirical data from a variety of sources to gain a deep understanding of the current practical situation to be improved. Common methods which allow you to do so include observations, surveys, focus groups and document reviews. In this case too, both qualitative and quantitative data are collected and analysed.

2.5.3 Evaluation

The evaluation of action research will include the following questions:

1. Reliability:
    - Has the work used an iterative cycle of plan-act-reflect? How many cycles were conducted?
    - Was the research collaborative? Is the level of collaboration achieved appropriate?
    - Were the data generation and analysis methods appropriately described?
2. Bias:
    - Have the researcher's personal stake and potential biases been discussed? Was a reflexivity account included?
    - Is there a reflection on self-delusion and groupthink[•] or of the collaborators? How was this mitigated? Was the mitigation successful? If not, what was the outcome?
3. Valididty:
    - Was the learning from the plan-act-reflect cycle clearly identified and discussed?
    - Were the data generation methods appropriate, and was enough data generated?

[•] Groupthink is a tendency to conform to majority option to maintain unanimity and avoid confrontation.

- Were detailed descriptions and accounts of findings provided?
- Has the research generated both knowledge and action leading to change? How useful or impactful on practice are they?
- Were generalisations made and appropriately supported by evidence, including triangulation?

2.5.4 Is this strategy right for me?

There are conditions for this strategy to be successful:

1. Action research focuses on action aimed at solving real-world problems in professional and other social contexts. If that's not the case for your research, then you should consider a different strategy.

2. The action researcher is expected to be embedded in the context in which the research takes place, and have a professional stake in addressing the problem beyond the research itself, for instance, as an employee of an organisation. If this is not the case for your project, then you should consider case studies instead.

3. Action research requires the involvement of other practitioners as collaborators in the research. This goes beyond being merely participants in surveys or observations: instead it requires a much higher commitment and continuous involvement in the study. If this is not possible, you should consider case study research instead.

4. Action research works through reflection, and continuous learning and improvement. As such, it does not exhibit the same level of scientific rigour as, for instance, an experiment. If scientific rigour is needed in your research, then you should consider a different strategy.

5. Action research may not be suitable to study complex causal-effect relationships. If you need to establish one such relationship, then you should consider the experimental strategy instead.

6. Generalisation can also be difficult to achieve with action research. If you need to be able to generalise your research widely, then consider case studies instead.

7. While action research is accepted and commonly applied in some social sciences, like education and healthcare, this may not be the case in your discipline. You should therefore check with your supervisor whether this strategy is acceptable or you should consider a different, strategy.

2.5.5 Further reading

To deepen your understanding of this strategy, you can start from **oates2008researching**; **johannesson2014research**.

2.6 Ethnography

The ethnography research strategy aims to study the culture of a group of people in their natural setting.

2.6.1 Knowledge contribution

Ethnography contributes to knowledge by providing a cultural characterisation of the group under study. Such characterisation should be one that the group members recognise and find familiar, and should be inclusive of various cultural facets, both social and economical, rather than focusing solely on one specific aspect.

While ethnography was originally developed within the discipline of anthropology, particularly for the study of indigenous populations, it can be applied widely in social settings, for instance to study the work culture within a particular profession or organisation, or the culture of online communities within social media.

2.6.2 Data generation and analysis

The researcher is expected to join the group and share what the group members' experience in their natural social setting in order to gain an insider's perspective and arrive at a rich, detailed characterisation. This requires the researcher to make detailed participant observations, appropriately recorded in field notes, accompanied by gathering detailed data through interviews and document reviews, linking them to the existing literature and reflecting on what they have learnt from their own experience, including their state of mind and emotional reactions. Data generation and analysis are predominantly qualitative.

2.6.3 Evaluation

Evaluating ethnography may involve asking the following questions:

1. Reliability:

- Are field notes sufficiently rich and detailed? Do they capture people's actions and behaviours, and the motivating reasons?

2. Validity:

   - Is the cultural characterisation obtained sufficiently rich to account adequately for the group's beliefs, customs, behaviours and interpersonal relations?
   - Was adequate time spent with the group in their natural setting? What reflection has been done on such time?
   - Are data appropriately interpreted through a cultural lens?
   - Is the ethnographic characterisation a standalone description, or has it been linked to theory, other ethnographic studies or issues in other cultures?

3. Bias:

   - Does the research include a reflexive account of the researcher?

2.6.4 Is this strategy right for me?

There are conditions for this strategy to be successful:

1. Ethnography requires you to be a researcher located within the context of your situated research, for instance your employer organisation, where the research is likely to require an extensive amounts of time. If you have yet to have identified the context, or have yet to reach out to obtain permission to proceed, then this requirement may mean that ethnographic research may not be feasible. So, if you are not already close to your context of research, you may wish to consider case study research instead.

2. Even if you are already located within the context of your ethnographic research, the context must be accepting of an ethnographic approach for your research to be successful. An organisation, for instance, in which there is a culture of strict compartmentalisation may not provide sufficient opportunities for ethnographic research.

3. In ethnographic research you allow the culture under study to determine the outcomes of the research, so you should approach it without any preconception or bias. If there is any possibility that you could

be biased to a particular outcome – as might happen if you feel you already know the outcome and are simply trying to confirm this – then ethnography is unlikely to lead to a successful outcome for your research. Any competent ethnographer will be particularly sensitive to expressions of such confirmation bias.

4. Ethnography can lead to rich descriptions of complex social settings, and the characterisation produced may be very deep in representing a particular group culture. However, this may be difficult to generalise to other social groups or settings. If generalisation is an important aspect of your research, then you should consider case studies instead.

2.6.5 Further reading

To deepen your understanding of this strategy, you can start from **oates2008researching**; **johannesson2014research**.

2.7 Systematic research reviews

A systematic research review is used to generate new insights from published work, linked to a clearly defined research problem or question.

2.7.1 Knowledge contribution

A systematic research review is meant to advance a field of study by providing insights from across the literature not contained in individual research papers. It uses a rigorous set of criteria to identify, select, and critically appraise relevant research from previously published studies in order to generate a scholarly synthesis of the evidence in relation to an explicit research problem or question.

For example, a systematic research review could be conducted to generate new insights on the effectiveness of a specific medical treatment, in order to advance evidence-based medicine: published articles on randomised controlled trials for that treatment could be reviewed and a judgement made based on a synthesis of the results from the accumulated body of work.

2.7.2 Data collection and analysis

In a systematic research review you only use evidence from published studies and rely on explicit, reproducible methods to identify the relevant research to review. Specifically, you must decide upfront your research problem/question and the set of criteria you will use to select, compare and evaluate those studies, and combine their results.

The type of analysis you will conduct will depend on the nature of the evidence you are considering and combining. In *narrative reviews*, a narrative synthesis is produced of qualitiative results, while in *meta-analysis*, statistical techniques are used to analyse and combine quantitative results. Combinations of the two are also possible.

2.7.3 Evaluation

Evaluation of the systematic research review will involve answers to the following:

1. Reliability:
    - Are the criteria used to select, exclude, evaluate and combine the published research explicit and reproducible? Were there any deviations from this protocol and, if so, are they explained, justified and documented?
2. Validity:
    - Has the researcher accessed all relevant published research in the area?
    - Have the relative strengths and weaknesses of the research reviewed been described? To which extent have conflicts between sources been identified and, when appropriate, resolved?
    - In combining results from different studies, are significant differences between those studies appropriately acknowledged?
    - To which extent has a definitive synthesis from the literature been achieved? To which extent are the limits of current knowledge described?
    - To which extent has precision and/or generalisability been improved through the systematic research review?

- In meta-analysis, to which extent have statistics been used to produce overarching conclusions? Were the studies sufficiently homogeneous for meta-analysis to be feasible?

3. Bias:

   - In narrative reviews, to which extent potential bias has been acknowledged and mitigation measures applied?

2.7.4 Is this strategy right for me?

You should consider the following points when choosing this strategy:

1. A systematic research review is both systematic and extensive in its coverage of the topic of interest. This requires you to have a very good grasp of the subject area in order to establish appropriate criteria for the selection of all relevant published work, and this may lead to a large body of work to review. If you lack such knowledge of the filed of study or the time to conduct an extensive review of the literature, then you should consider a different strategy.

2. A systematic research review assumes that there is a substantial body of knowledge already published from which new insights can be generated. In emerging research areas, this may not be the case, so that a systemic research review is unlikely to reach any meaningful synthesis. If there is paucity of literature on your chosen topic, then this strategy is not for you.

3. You need relatively easy access to the academic literature to be able to select the body of work to review, for instance, through a university library with a large research collection in your chosen discipline. If not, you will need to devise alternative ways to access the relevant literature, like contacting the author(s) directly. Although most authors will be happy to send their published research to you, the round trip time can introduce lengthy delays in the research process as you wait for the requested research to arrive. You may also need to be persistent to ensure that a busy author is aware of your research need. If you don't think you will be able to access easily a large proportion of the published work you need, you should rethink your research strategy.

4. Systematic research reviews are required to be transparent, reliable, and easy to replicate. You will be expected to have stated explicit inclusion and exclusion criteria so that another research would be able to arrive at the same collection of published work, and ensure that no inherent bias has influenced

such choice. Choosing appropriate criteria may be difficult and may require you to iterate, starting perhaps from a broader focus, then narrowing it down as your research progresses. This, too, can be time consuming, so if your time is limited, you should consider a more time-efficient strategy for your research, perhaps one which allows you to generate your own primary evidence.

2.7.5 Further reading

To deepen your understanding of this strategy, you can start from **wright2007write**; **moher2009preferred**; **pollock2018systematic**.

In addition, you should consider the PRISMA statement[•], a 27-item check-list whose aim is to help authors improve the reporting of systematic reviews and meta-analyses.

• http://prisma-statement.org/prismastatement/checklist.aspx

2.8 Grounded theory

Grounded theory aims at defining theories[•] on social phenomena based[•] on empirical data. The intention is for the theory to emerge from the collection and analysis of the data, rather than using the data to confirm or disprove a previously formulated theory, or test a previously formulated hypothesis.

• In simple terms, a theory is a system of ideas intended to explain something.

• I.e., 'grounded', hence the name!

2.8.1 Knowledge contribution

Grounded theory contributes knowledge in the form of theories concerning complex social phenomena, striving to provide explanations of people's choices and actions grounded in those people's own accounts and interpretations.

For example, grounded theory could be used to formulate theories on what motivates people to join or leave a particular organisation, or why employees may feel fulfilled or frustrated in their workplace.

2.8.2 Data collection and analysis

Grounded theory requires the systematic collection and analysis of data without any preconceived belief or theoretical framework. The data are collected, coded and analysed to identify emerging concepts, categories and relationships. The process is iterated with new data used to review and revise those concepts, categories and relationships until no more can be gained from further data collection and analysis. At this point a

theory is put forward based on what was derived from the data. In this process, it is essential to be open to multiple explanations, and to explore the data from all angles in order to gain a fresh perspective.

2.8.3 Evaluation

The following questions should be addressed in evaluating grounded theory research:

1. Reliability:
    - Was the process followed to arrive at the theory appropriately described? Was it systematic and iterative?
2. Validity:
    - Were sufficient data collected and described? How relevant were they to the phenomenon under study?
    - Which concepts, categories and relationships were generated by the research? How are they grounded in the data? How do they contribute to the theory?
    - Has the phenomenon been examined under a broad range of conditions and from a variety of perspectives?
    - Is the theory plausible in relation to the data? Does it provide sufficient explanation of the phenomenon under study? Is it general enough to account for variation in conditions and context of application?
    - Can the theory be easily understood by its intended users? How useful is it in helping them understand their social reality and be the basis for action?
3. Bias:
    - Is there a reflexivity account of the researcher to guard against possible bias?

2.8.4 Is this strategy right for me?

In choosing this strategy, you should consider the following:

1. Grounded theory is about letting the "data to do the talking" **drew202310-grounded**, so you should not have any prior belief, theory or hypothesis you wish to put to test. If that's not the case, other strategies are more appropriate, like case studies, ethnography or experiments.

2. Grounded theory requires you to gather a significant amount of empirical data, making sure you examine a social phenomenon under various conditions and from many perspectives. If you do not have access to such data, then grounded theory cannot get started, and you should consider other strategies.

3. Grounded theory is generally time consuming, given the iterative nature of the process of gathering and analysing data. If time is an issue in your project, then you should choose a more time-efficient strategy, like case studies or experiments.

4. Grounded theory aims at generating theories concerning social phenomena. If a new theory is not the aim of your work, then you should choose a different strategy, like ethnography or case studies.

5. Grounded theory is particularly useful when there is a paucity of theories in relation to the phenomena of interest. If there are already several theories available, it is less likely grounded theory will be able to contribute something new. In such cases, you should rethink whether a new theory is actually needed or choose a different aim and strategy for your project.

2.8.5 Further reading

To deepen your understanding of this strategy, you can start from **smith1997understanding**; **drew202310-grounded**; **corbin1990grounded**; **strauss1998basics**; **gibson2013rediscovering**; **charmaz2014constructing**.

2.9 Phenomenology

Phenomenology is a research strategy that focuses on people's conscious experience of a phenomenon, that is how people perceive and give meaning to it, including any feeling and emotions it evokes.

2.9.1 Knowledge contribution

Phenomenology contributes knowledge by providing insights into people's lived experience, seeking to describe or interpret the essence of a phenomenon from the perspective of the people who have experienced it.

For instance, a phenomenological study of patients emergency care could focus on the experience of nurses and doctors in emergency departments.

2.9.2 Data generation and analysis

Data generation in phenomenology is primarily through in-depth, unstructured interviews and focus groups, which should allow participants to give their own account of their experience and surface key issues, without being influenced by the researcher. These are often complemented by participant observation, in which the researcher is immersed in the day-to-day activities of the study participants, hence sharing their experience of the phenomenon of interest. Audio and video recording, alongside field notes and journals are used to record data.

Data gathering typically results in a large quantity of qualitative data, which are both detailed and unstructured, so that qualitative methods are then needed for their analysis. The analysis process requires the researcher to set aside any preconception, assumption or bias[•] and focus solely on the data, considering every participant's statement or expression as equally important and relevant.

[•] This is referred to as 'bracketing'.

2.9.3 Evaluation

The following questions should be asked of phenomenological research:

1. Reliability:
    - Are the criteria for selecting the study participants properly explained and justified?
2. Validity:
    - Is the phenomenon accurately and objectively described? Is the account provided one that can be recognised by anyone who has experienced that phenomenon?

- How have similarities and differences in the participants' experience of the phenomenon accounted for in the study? How are they dealt with in the data analysis, particularly in the coding and categorisation process?

3. Bias:

   - Is there a reflexive account of how judgments were suspended to focus on the analysis of experience?

2.9.4 Is this strategy right for me?

In choosing this strategy, you should consider the following:

1. The focus on phenomenology is lived experience, to uncover what is really like to experience a phenomenon from the perspective of those who have lived through it. If you do not have access to participants who can share their experience, then you should consider a different strategy.

2. Phenomenology asks you to suspend any prior belief on the phenomenon and only focus on the participants' experience. If you have a theory or hypothesis you want to test, then you should choose a different strategy.

3. The amount of qualitative data to gather and analyse is considerable, and this can be very time consuming. If time is an issue in your research, then you will need to choose a more time-efficient research strategy.

4. Phenomenology is about going deep into the experience of a phenomenon, and this constrains the number of participants in your study. If you are more interested in gaining consensus from a large number of participants, or making general predictions from your sample data, then you should choose something else, like survey research or grounded theory.

2.9.5 Further reading

To deepen your understanding of this strategy, you can start from **merleau1956phenomenology**; **anderson1991qualitative**; **smith2018phenomenology**; **shudak2018phenomenology**; **academic-educational-materials2019understanding**; **office2020the-phenomenological**; **groenewald2004a-phenomenological**; **hycner1985some**.

2.10 Simulation

The simulation research strategy builds an explicative mechanism to imitate or reproduce the behaviour of a real-world artefact or system.

2.10.1 Knowledge contribution

Simulation contributes knowledge by allowing the study of the simulated artefact or system under different conditions, in order to answer "What if?" questions, make predictions or gain insights on behaviour or properties, particularly when this can't be easily achieved directly on the real-world artefact or system.

Simulations are used in all disciplines and vary greatly in their purpose, nature and design. For instance: financial simulations are used to study the behaviour of the global stock market; climate simulations to study possible effects of climate change; engineering simulations, to test the properties of materials under different stress conditions; social simulations to study human behaviour in social settings, to name just few examples.

2.10.2 Data generation and analysis

Data are needed to inform the simulation design. Their kind and how to obtain them will depend strongly on the nature of the artefact or system under study and what your research aim is, so that all known methods for data generation apply. For instance, to simulate a new aircraft design under different wind conditions, you may need to gather data on the physical characteristics of the aircraft and the materials to be used to build it, alongside meteorological data which can be used to perform tests under different simulated conditions. On the other hand, to simulate how size and age of a population may change in future decades within a particular geographical region, you may need to gather data on current population size and age, birth and mortality rates, migration rates in and out of the region, and conditions which may affect them over time.

Data are also needed to establish measures and criteria to evaluate whether the simulation is sufficiently representative of the artefact or system being simulated. This may involve comparing simulation outputs with empirical data or theoretical predictions, or gathering expert opinions on such outputs, with the aim of establishing the extent expectations are met or significant discrepancies exist.

Whichever methods you use to gather data for your simulation design, once constructed, the simulation should allow you to generate observations of the simulated artefact or system, both past, present and future, the latter being a unique characteristic of this research strategy•. Such observations can then be analysed in

• All other strategies can only look at the past or the present.

order to address the research question, as well as to evaluate the simulation against the established measures or critera.

2.10.3 Evaluation

Evaluation questions specific to this strategy include:

1. Reliability:
    - Is the simulation design appropriate to address the research problem/answer the research question?
    - Were simulation performance measures or criteria clearly established? How were they chosen and why?
    - How was the simulation constructed? Were appropriate computational/mathematical/statistical techniques applied?
2. Validity:
    - Were appropriate data gathered to inform the simulation design? How were they chosen and why?
    - How was the simulation tested and improved during its development? Were different testing methods applied and the results documented?
    - How close are the simulation's outputs or behaviours to the real-world data? How was this established? Do the results make sense?

2.10.4 Is this strategy right for me?

Is you are considering the simulation research strategy, then you should consider the following:

1. The design and construction of a simulation requires advanced computational skills, often alongside mathematical and statistical skills. Do you already have such skills? If not, you are unlikely to be able to develop them in the time of your project, and should consider other research strategies instead.
2. Do I have access to the data, and possibly stakeholders, needed for the design and evaluation of the simulation? Without such data it is unlikely you would be able to build a representative simulation, hence you would not be able to generate valid and reliable results. In such case, you should consider other strategies.

2.10.5 Further reading

To deepen your understanding of this strategy, you can start from **dooley2017simulation**.

2.11 Mathematical and logical proof

Jon to go through this. I think we need both deductive and inducting proofs

A mathematical proof is a rigorous argument that demonstrates the truth of a certain proposition starting from certain assumptions. As long as the assumptions are true, then an argument is constructed in a way that guarantees that the proposition is also true. Such argument is termed 'deductive' as it starts from the assumptions and arrives at the proposition as the conclusion of the reasoning.

When the reasoning is carried out within a fully formal logical system, then we have a logical proof.

2.11.1 Knowledge contribution

Mathematical and logical proofs contribute knowledge in the form of true propositions, which are the means by which Mathematics functions and grows its scope and applicability.

Give example

Within a mathematical system, such truths are absolute, something which does not hold in any other scientific discipline: even in the natural sciences and by taking a (post-)positivist stance, truths are always only tentative and falsifiable, in that they hold only until new evidence emerges to contradict them.

2.11.2 Data generation and analysis

rethink data gen. here; add inductive and deductive reasoning

In this strategy, it does not make sense to talk about data generation and analysis.

Instead, all mathematical disciplines, relies on sets of assumptions and previously proven propositions which are taken as the starting point to generate, through proofs, new propositions, that is new truths.

2.11.3 Evaluation

A new proof is subject to the scrutiny of the community of mathematicians, which employs various means to check both assumptions and reasoning, so as to reach a verdict on the reliability and validity of the proof.

Such means may include using alternative deductive reasoning to check they can reach the same conclusion, using examples in support of the reasoning, or even recreating a mathematical proof within a fully

formal system or using a computer-based automated checker, when applicable. You could adopt some of these approaches to improve or defend the reliability and validity of your proof.

2.11.4 Is this strategy right for me?

If you are considering this strategy, you should ask yourself:

1. Mathematical and logical proofs only make sense within research which is amenable to formalisation. Is that the case for your project? If not, then the notion of proof may not apply and you should consider an empirical research strategy instead.
2. You will need to be a skilled mathematician or logician to come up with a proof that can withstand the scrutiny of the mathematical community. Do you possess such skills? If that's not the case, then this strategy may not be for you•.
3. Ideally, you should seek formative feedback from an experienced mathematician as you develop your proof, to reduce the chance of mistakes or reasoning pitfalls. Do you have access to such an expert advice? If not, you should discuss with your supervisor to ensure they do have the skills to take up that role.

• One way to determine whether your background is suitable would be to read the first few pages of **lakatos2015proofs** (up to page 9 is available through google books).

2.11.5 Further reading

To deepen your understanding of this strategy, you can start from **Kleene1964introduction**; **lakatos2015proofs**; **antonini2011examples**; **johannesson2014research**.

2.12 Mixed methods research

The mixed methods research strategy• combines elements of both qualitative and quantitative research, with the aim to increase both breadth and depth of understanding of the phenomenon under study, and corroboration of results, giving more confidence in the conclusions reached. As a result, triangulation is in-built within the strategy.

• Mixed-method research should not be confused with *multi-method research*, which simply indicates the use of many methods, possibly all qualitative or quantitative.

2.12.1 Knowledge contribution

The knowledge contribution is the combination of the knowledge contributed by each of the methods applied, appropriately synthesised by considering connections and contradictions between qualitative and quantitative data.

Mixed method research is particularly suited to interdisciplinary research and to the study of complex situations or social settings, particularly when one kind of method alone would not deliver the desired depth of understanding or richness of results. For example, within urban planning, you may be interested in improving pedestrians' safety, so that a mixed methods study may consider both quantitative data on pedestrian accidents and qualitative data on pedestrians' experiences and perceptions in order to identify both safe and dangerous areas to both learn lessons and plan remedial actions.

2.12.2 Data generation and analysis

How data are generated and analysed will depend on how the different methods are combined. Typical combinations include:

- parallel, in which separate qualitative and quantitative methods are applied to gather different sets of data. For instance, your collection of pedestrians' accident data, and pedestrian's opinions may occur in parallel, independently of one another, then the results may be analysed and compared.
- sequential, in which the methods are applied one after the other, with outcomes from the first used to inform the second. For instance, you could start with the pedestrians' experience, then collect accident data on areas which are perceived as particularly safe or dangerous.
- nested (or embedded), in which a quantitative method is applied within a wider qualitative method (or vice versa). For instance, the focus may be primarily on the qualitative pedestrians' experience, within which some statistical analysis is applied, for instance, to look for correlations between such experience and accident data.

2.12.3 Evaluation

Evaluation questions for this strategy will include questions on the specific methods which are combined, alongside the following questions on their combination:

1. Reliability:
   - How was the use of mixed methods justified in relation to the phenomena of interest? How has the study benefitted from their combination?
   - Is the way the methods are combined appropriately described?
2. Validity:
   - How were connections between qualitative and quantitative findings established?
   - How were conflicting or mismatched results from the different methods handled?

2.12.4 Is this strategy right for me?

If you are considering mixed methods research, you should take the following into account:

1. Mixed methods research requires competence in more than a single research method, which takes time to develop. If your Masters project is your first research project, it is unlikely you will have a developed understanding sufficient to apply the mixed methods research strategy, and you should consider a single method strategy. However, if your work is part of broader mixed methods research, perhaps led by your supervisor, then you may be able to contribute by focusing on the particular method you are being asked to work with.
2. Collecting and analysing both qualitative and quantitative data requires substantial time and resources. If this is going to be an issue, then a strategy with a single method focus would be a better choice.

2.12.5 Further reading

To deepen your understanding of this strategy, you can start from **johnson2007toward**; **denzin1978research**; **webb2000unobtrusive**.

Chapter 3

Choosing and drafting your own research strategy

By now you should have narrowed down your list of candidate strategies to few choices, and possibly discussed those choices with your supervisor. It is now time to learn more about them in order to make a final choice for your project.

While the content of this section is brief, the two activities it contains are going to be demanding. It is important, however, that you don't skip them as they provide the foundation for your work in Stage 4.

Activity: Choosing your research strategy #7

For each candidate strategy in your list, consider the references you have recorded in your bibliographical database, and review the related literature in order to learn more about the strategy, and how you it may apply practically to your project.
At the end of the activity reach a decision on which research strategy, or combination of strategies, to adopt.

Guidance

The references we have provided are only a starting point, and you should also explore other literature on the topic. There is a vast literature on research methods, so it is easy to get lost. We recommend you look at introductory materials first to gain a broad understanding, then delve into more specialised

literature for some of the details. Your supervisor will also be able to suggest appropriate reading.
As you read the literature, you should take notes to augment the summaries we have provided in the previous section, to capture your deeper engagement and growing understanding of each research strategy. By the end of this activity you should have gained a good general understanding of how each strategy reviewed may suit your research.
In your review, you should pay particular attention to possible data generation and analysis methods under each strategy, reflecting on which may be most applicable to your project and how, alongside any risk or other factors which may affect their successful application.
It is not necessary for you to learn the fine details of each method at this point. However, by the end of this activity, you should have a clear idea of which methods you will be focusing on in Stage 4, in which you will engage with the specific procedures to apply those methods in your own project.

Your final activity in this chapter is a writing task: to draft your chosen research strategy, as a starting point for the narrative you will develop during the remainder of your project and eventually include in your dissertation. We recommend you apply the template in Table 3.1 to structure your writing.

LR: possibly add columns with reference to relevant sections?

Activity: Sketching your research strategy #8

Apply the template in Table 3.1 to provide a first draft account of your research strategy.

Guidance

This first draft will be necessarily tentative, but it should provide a good starting point that you can grow and revise alongside your increasing understanding and practical application of your strategy.
It is important that you engage with all elements of the template, including the evaluation section: although your full evaluation will only be completed at the end of your project, it is essential that you start thinking about the questions you will need to address. This, in turn, will help you ensure that the steps you take in your strategy application are likely to provide satisfactory answers to those questions.

Table 3.1: How to summarise your research strategy

Section	**Content**
Choice and justification	Indicate which strategy, or combination of strategies, you have chosen and justify this choice by considering how it aligns with the aim of your research in relation to the way it contributes new knowledge
Mindset and research paradigm	Discuss how this strategy is consistent with your own mindset, with reference to the research paradigms introduced in Stage 2
Reflexive statement	Summarise your own standpoint as a researcher, including specific assumptions, beliefs and potential bias you bring to the research, and the steps you will take ensure they will not weaken your research
Data and sources	Indicate the kind of data you will need to generate and analyse in your project, possible data sources you will focus on and how you will gain access
Data generation and analysis methods	Indicate the selection of methods you intend to apply in your data generation and analysis. Explain why you think they are suitable and feasible
Ethical issues	Indicate all ethical issues relevant to your chosen research strategy, including listing any regulations you may need to comply with, and explicit permissions you may need to obtain to be able to proceed with your research
Research evaluation	Reflect on the potential weaknesses which may affect your chosen strategy, and consider the related evaluation questions from the previous section, alongside other evaluation criteria you may have found in the literature. Highlights those which are most relevant to your project and indicate which actions you may take to address them

Chapter 4

Reflecting and Reporting in Stage 3

More here

Chapter 5

Stage 3 Takeaways

More here

Closing

Your dissertation submission concludes your Masters project work. If you have come that far, then you deserve much praise and this is a significant intellectual achievement. A successfully project is a strong indication that you have mastered a wider range of research and transferrable skills, which are of great value to your professional development and provide a strong foundation for any future academic or professional research you may choose to pursue, including doctoral studies.

We hope you have found conducting your own research rewarding, despite, and perhaps because of, the challenges that undoubtably you will have encountered and overcome during your project. We also hope you will have found this handbook valuable in supporting you throughout your project.

We wish you all the best for your future career and studies!

Glossary

Academic literature: the collection of all published research and scholarly work.

Active reading: engaging with written materials in a way which allows you to assimilate the important points in an effective manner

Artificial Intelligence (AI): a sub-discipline of Computing, aimed at creating software systems able to simulate human intelligence processes.

Bibliographical database: a searchable collection of academic literature.

Bibliographic Management Tool (BMT): software tool used to collect and save searchable information concerning articles and other literature sources reviewed during research, including digital copies of articles and personal notes, and to generate references, reference lists and bibliographies in a variety of bibliographical styles.

Bibliography: a separate section, usually towards the end of a document, which collects full bibliographical information of sources, whether cited or not, which are relevant to the content of the document.

Bibliographical style: a set of rules which determine what citations and references should look like in academic writing.

Categorical (or nominal) data are qualitative data corresponding to categories that cannot be ordered and on which mathematical operations and function don't apply, e.g., full-time vs part-time study.

Citation: a short-cut that appears in the main body of a written academic piece to refer to a specific source in the academic (or other) literature.

Citation searching: a technique for exploring the literature based on citations in academic articles.

Critical writing: writing displaying a good balance between description, analysis, synthesis and evaluation.

Correlation: statistical relationship among two or more measures, concerning how changes in one measure are reflected in changes in the others.

Data analytics tool: sophisticated digital tools which extend spreadsheet capabilities for collating and visualising data to include some degree of automated analysis, both statistical and based on Machine Learning algorithms.

Descriptive statistics: measures used to provide meaningful summaries of data points within a dataset.

Gantt chart: a scheduling chart used to plan, organise and monitor activities and work over the duration of a project.

Google Scholar: a web search engine specialising in scholarly content.

Grey literature: collection of information produced by organisations whose primary or commercial remit is not publishing, such as as universities, government bodies or businesses (other than publishers). It includes pre-publication and non-peer-reviewed articles, theses and dissertations, research and committee reports, government reports, conference papers, accounts of ongoing research, etc.

Interval data are ordinal data, but for which we can calculate precisely the interval between any two data points. For instance, calendar dates are interval data in the sense that we can calculate precisely the interval between two given dates, e.g., the number of days in between.

Kanban board: an agile project management tool to help individuals or teams organise and track their progress on specific tasks during a project.

Machine Learning (ML): a branch of Artificial Intelligence aimed at creating software systems able to learn autonomously and improve from experience.

Numerical data are numbers, either discrete or continuous, e.g., the number of students on a module (discrete) or the average temperature in the UK in July 2023 (continuous). Numerical data can be ordered, and mathematical and statistical operations and functions apply.

Nominal data: same as categorical data

Ordinal data are data that can be arranged in an order, but are not necessarily numerical, e.g., a 5-point Likert scale from (1) Strongly disagree to (2) Disagree to (3) Neither agree nor disagree, to (4) Agree to (5) Strongly agree. While these values can be arranged in the order indicated, mathematical and statistical operations and functions don't apply.

Plagiarism: passing off someone else's work, words or ideas as your own, often as a deliberate attempt to deceive.

Research asset: information which is needed, gathered or generated by your research, including articles, data, images, tables, notes, etc, organised and managed in a disciplined and systematic manner.

Qualitative data: descriptive data, like texts, words, images, sounds, etc., including categorical (or nominal) data, e.g., full-time vs part-time study or employed vs unemployed.

Quantitative data: data that can be quantified or measured, and be given numerical values, including numerical, ordinal and interval data.

Reference: the full bibliographic information of a source in the academic (or other) literature which is cited in an academic text.

Risk: the likelihood of something going wrong combined with the impact that may have on a project.

Spreadsheet: a digital tool used to capture, display, analyse and manipulate data arranged in tables.

Version control system: a set of conventions or tools to keep track of different versions of documents and other research assets.

References and further reading

Cottrell, Stella. Critical Thinking Skills : Effective Analysis, Argument and Reflection, Bloomsbury Publishing Plc, 2017. ProQuest Ebook Central, https://ebookcentral.proquest.com/lib/open/detail.action?docID=6234915.

A practical handbook to develop your critical thinking skills, packed with activities and practical advice.

Cryer, Pat. The Research Student's Guide to Success, McGraw-Hill Education, 2006. ProQuest Ebook Central, https://ebookcentral.proquest.com/lib/open/detail.action?docID=316264.

A comprehensive introduction to research skills for post-graduate research students. Some elements are more relevant than others to Masters research, so this is a good reference book to dip in and out.

Potter, Stephen (ed.) (2006) *Doing postgraduate research*, SAGE study skills, 2nd edition., Los Angeles London New Delhi, SAGE.

Another comprehensive introduction to research skills for post-graduate research students, possibly more suited to PhD students than Masters students.

Etzold, Daniel 2020). My Workflow for Reading Scientific Papers. https://betterhumans.pub/my-workflow-for-reading-scientific-papers-d4b27dbb38a6

Some practical advice from a practitioner. This is a personal account, rather than a tried-and-tested method. Nevertheless, it contains some good tips that you may find useful.

References

Klopper, Rembrandt, Lubbe, Sam & Rugbeer, H., 2007. The matrix method of literature review. Alternation, 14(1), pp.262–276.

References

Keshav, S. (2007) 'How to read a paper', ACM SIGCOMM Computer Communication Review, 37(3), pp. 83–84.

References

Cottrell, S. (2005) Critical thinking skills. Basingstoke: Palgrave Macmillan

References

Cottrell, Stella (2017). Critical Thinking Skills : Effective Analysis, Argument and Reflection, Bloomsbury Publishing Plc.. ProQuest Ebook Central, https://ebookcentral.proquest.com/lib/open/detail.action?docID=6234915.

References

M. K. S. Sastry and C. Mohammed, "The summary-comparison matrix: A tool for writing the literature review," IEEE International Professional Communication 2013 Conference, 2013, pp. 1–5, doi: 10.1109/IPCC.2013.6623891.

References

Booth, W., Colomb, G.G. and Williams, J.M. (1995) *Making good arguments: an overview.* The Craft of Research, London: The University of Chicago Press.

Simon, H. A. (1969). The sciences of the artificial. The MIT Press.

References

Data Protection in the EU, https://commission.europa.eu/law/law-topic/data-protection/data-protection-eu_en (Last accessed: February 2023)

References

UKRI Equality, diversity and inclusions key principle. https://www.ukri.org/about-us/policies-standards-and-data/good-research-resource-hub/equality-diversity-and-inclusion/(last accessed: November 2022)