

INTRODUCTION TO A RESEARCH PROJECT

M2 S2I/IKSEM MIAE - SORBONNE

22

STEPS IN CONDUCTING A RESEARCH PROJECT

1. Identification of a practical problem – Motivation; *(optional)*
2. Identification of a research problem
3. Literature review
4. Determining specific research questions
 - Specification of a conceptual framework
 - Defining a set of explanatory hypotheses
5. Choice of a research methodology
 - Data collection
 - Verifying data
 - Analysing and interpreting the data

... Repeat the step until all the hypothesis are validated / refuted ...

.. If impossible to terminate the step – revise hypothesis (back to step 4)

.. If still impossible – back to step 3
6. Reporting and evaluating research
7. Communicating the research findings

MIAGE-SORBONNE M2 MASTER THESIS

- Phase 1 (TS1)
 1. Identification of a practical problem – Motivation; *(optional)*
 2. Identification of a research problem
 3. Literature review (iteration 1) → related works; to justify the project
 4. Determining specific research questions (RQ)
 5. Specification of a conceptual framework, (including a set of hypotheses)
 6. Choice of a research methodology
- Phase 2 (TS2)
 1. Literature review (iteration 2) → to define the background ; to validate the RQ
 2. Determining specific RQ (iteration 2)
 3. Specification of a conceptual framework, (including a set of hypotheses) (iteration 2)
 4. Choice of a research methodology ./Defining specific research protocol
 5. Data collection (iteration 1)
 6. Verifying data
 7. Analysing and interpreting the data (iteration 1)
- Phase 3 (TS3)
 1. Data collection (iteration 2)
 2. Verifying data
 3. Analysing and interpreting the data (iteration 2)
 4. Answering your specific RQ / Determining specific RQ (iteration 3)
 5. Evaluating results / Defining limits / Open RQ / Future directions
- Phase 4 (Thesis preparation/defence)
 1. Reporting research (writing a manuscript)
 2. Communicating the research findings (presentation, scientific publication)

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WHAT IS “A PROBLEM”?..

- Problem is a situation that has:
 - **A condition** that needs to be resolved
 - The hole in the ozone layer is growing
 - The complexity of IS in our company become unbearable
 - **Costs** of that condition that you do not want to pay
 - Many will die from skin cancer
 - It will cost to our department money and time to integrate a new SAP module
- OR:
- **Benefit** of having this condition resolved
 - If we fix ozone hole – we save many lives
 - If we reduce the complexity and consolidate the software – not only our SAP module but any further modifications will cost much less.
- **The greater the costs or the benefit –the more significant the problem**

(Booth et al., 2003)

EXERCISE: FIND A PROBLEM HERE...

- Examine the following research articles:

EXAMPLES..

- find a problem they address:
 - Condition
 - Cost and/or Benefit
 - Provide references from the text to support your answer!

PRACTICAL PROBLEMS AND RESEARCH PROBLEMS

- **Practical problem:**

- Originates in the real world (e.g., in an organization)
- Means trouble (for a project, for a client, for an organization..)
- Costs money, time, happiness, wellbeing, etc
- Can be solved by doing something.

- **In order to solve the practical problem you have to define and solve a research problem:**

- **Research problem:**

- Originates in your mind
- Means incomplete knowledge or understanding of something.
- Costs = the cost of ignorance. How high is it?..
- Can be solved NOT by changing something in the real world but by learning something and understanding it better.

RESEARCH QUESTION AND HYPOTHESIS

How to define?

How to document using a conceptual framework?

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RESEARCH QUESTIONS

- A **research question** is 'a question that a research project sets out to answer'
- Good research questions usually **complex, specific and relevant**
 - **Depends on the type of study (qualitative or quantitative)**
 - A research project must **explicitly** provide the answers to its RQ

See also Scribbr for writing a good RQ: https://www.youtube.com/watch?v=71-GucBaM8U&list=PLjBMY3HggCpAjmtPByI_MkFI6lrquHatL&index=2

__STRONG__ RQ CHECK LIST:

- Focused
- Researchable
- Feasible
- Complex
- Specific
- Relevant

RESEARCH QUESTION

- Exemple 1:

Jane is a new PhD student interested in the effectiveness of a novel fisheye-view file navigator. Her research is motivated by the fact that navigation is a primary activity of software developers requiring a lot of scrolling and many clicks to find files. 'Fisheye-views' use a distortion technique that, if applied correctly, display information in a compact format that could potentially reduce the amount of scrolling required. Jane's intuition is that the fisheye-view file navigator is more efficient for file navigation, but critics argue that the more compact information is difficult to read and that developers will not adopt it over the traditional file navigator. Her research goal, therefore, is to find evidence that supports or refutes her intuition that fisheye-view file navigators are more efficient than traditional file navigators for navigation.

RQ: "Is a fisheye-view file navigator more efficient than the traditional view for file navigation?"

(Eastbrook et Al., 2008)

RESEARCH QUESTION

- Exemple 2:

Joe is a researcher in an industrial lab. His current interests are in understanding how developers in industry use (or not) UML diagrams during software design. This is because, as a student, his professors recommended UML diagrams be used during software design, but his recent exposure to industrial practices indicates that UML is rarely used. His research goal is to explore how widely UML diagrams are used in industry, and more specifically how these diagrams are used as collaborative shared artefacts during design.

RQ: “How widely are UML diagrams used as collaborative shared artifacts during design?”

(Eastbrook et Al., 2008)

DISCUSSION:

- **“Is a fisheye-view file navigator more efficient than the traditional view for file navigation?”**
- **“How widely are UML diagrams used as collaborative shared artifacts during design?”**
- How strong are the RQ above?
- Do they rely on some (implicit) assumptions?
 - What are they?

“Defining the precise meaning of terms is a crucial part of empirical research, and is closely tied with the idea of developing (or selecting) an appropriate theory.”(Eastbrook et al.,2008)

HIDDEN ASSUMPTIONS/AMBIGUOUS TERMS

- All the assumptions need to be explicit
- Pay attention to the following terms in your RQ:
 - Performance
 - Quality
 - Efficiency
- Define: Who's point of view? (user, client, engineer, manager ...)
- How to measure?
- Pay attention when you wish to compare 2 or more (solutions, technologies etc):
 - Do not use abstract adjectives (EX: better, more productive/efficient etc)
 - **Define and use specific metrics**

KINDS OF RQ

■ Descriptive (existence, classification comparison)

- What is X? What is X like? What is the purpose of X? When does X happen?
- What KINDS of X exist?
- What is the difference between X and Y?

■ Explanatory (why- and how- questions)

- What causes X? How X happen?
- Why X happen?

EXERCISE: KINDS OF RQ

1. Define different kinds of RQ for Jane and Joe
2. Examine your research question: Which kind is it?
3. Based of your RQ: Define more research questions of different kinds

RESEARCH HYPOTHESIS

- The research question may be supported by **hypothesis**:
- A **hypothesis** (plural **hypotheses**) is ..
 - A proposed explanation for a phenomenon.
 - A testable prediction which designates the relationship between two or more variables.
 - Related to your RQ: What is being tested?



https://www.youtube.com/watch?v=PCgLjDDD4ek&list=PLjBMY3HggCpAjmtPByI_MkFI6lrguHatL&index=4&pp=iAQB

HOW TO DEFINE A HYPOTHESIS?

- Define the effect you expect to observe
 - What measurements are needed to demonstrate this effect?
- **Example:** *Design method A yields better quality software than design method B*
 - *What is quality? How do you measure it? (ex: # errors produced, amount of efforts, duration of a project, complexity?..)*
- Define what is NOT expected to happen (null hypothesis)
 - **Example:** method A and B have no difference
- Define only the effects that interest you
 - Example: We do not consider the cost of the method application
- Consider that the same effect:
 - Cannot be measured “directly” (i.e., “surrogate measurements”)
 - Can be measured differently (e.g., perception of **quality** for users vs. quality for developers)

VARIABLES

- Independent variables – what we can vary in the experiment (e.g., the choice of an applied method), the CAUSE
- Dependent variables – what we observe (e.g., the # of errors), the EFFECT

EXERCISE:

- Exemple 1:

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RQ: “Is a fisheye-view file navigator more efficient than the traditional view for file navigation?”

- Define 2 or more research hypotheses for Jane
- For each, identify:
 - Independent variable
 - Dependent variable

EXERCISE:

- Exemple 2:

Joe is a researcher in an industrial lab. His current interests are in understanding how developers in industry use (or not) UML diagrams during software design. This is because, as a student, his professors recommended UML diagrams be used during software design, but his recent exposure to industrial practices indicates that UML is rarely used. His research goal is to explore how widely UML diagrams are used in industry, and more specifically how these diagrams are used as collaborative shared artefacts during design.

- RQ: “How widely are UML diagrams used as collaborative shared artifacts during design?”

- Define 2 or more research hypotheses for Joe
- For each, identify:
 - Independent variable
 - Dependent variable

EXERCISE:

- Work with your RQ
- Write down some hypothesis
- How can you test your hypotheses?
 - What data do you need to collect?
 - What do you need to look at/observe?
 - Variables, relations between variables, other?..

CONCEPTUAL FRAMEWORK

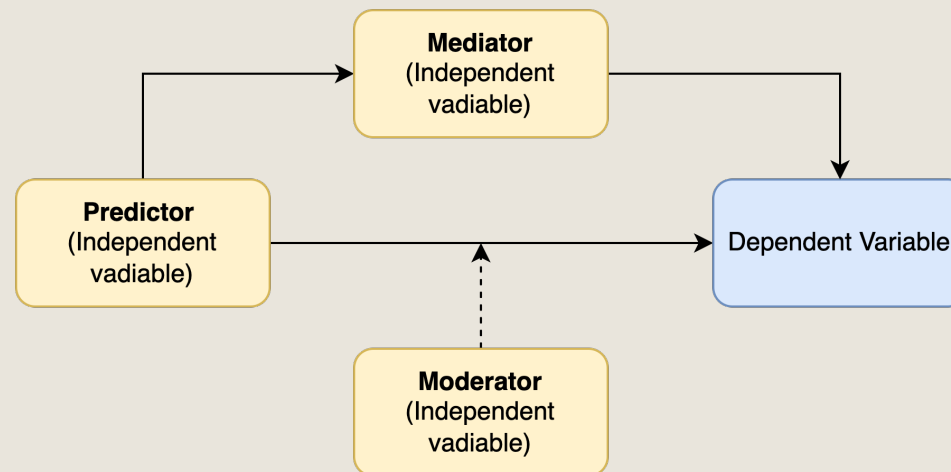
- Conceptual frameworks specify a set of constructs and the relationships between them that explain a phenomenon of interest.
- Conceptual framework is a written or visual representation of an expected relationship between variables identified in the study
 - Dependent, independent, moderator, mediator, control variables
 - Research Hypothesis

See also: <https://www.scribbr.com/dissertation/conceptual-framework/>

1. *Shields, Patricia; Rangarajan, Nandhini (2013). A Playbook for Research Methods: Integrating Conceptual Frameworks and Project Management. Stillwater, OK: New Forums Press. ISBN 978-1-58107-247-1.*
- 2.: <https://www.edrawsoft.com/conceptual-framework.html>

HOW TO DEVELOP A CONCEPTUAL FRAMEWORK?

- Conceptual model is **REQUIRED** when applying the following methodologies:
 - Survey
 - Controlled experiment
- Explains and sets up the context for your Research Question
- Formalises your hypothesis

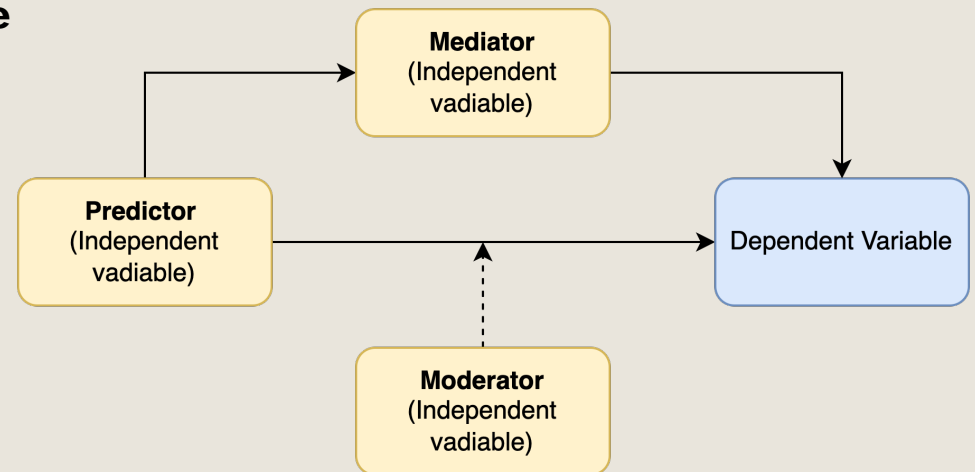


HOW TO DEVELOP A CONCEPTUAL FRAMEWORK?

- The **independent variable** is what you **change** – **CAUSE** or **PREDICTOR**.
- The **dependent variable** is what you **observe and measure** as an outcome – **EFFECT**.

Example in a Controlled Experiment:

- **Hypothesis:** "Using an interactive learning method improves student performance compared to traditional lectures."
- **Independent Variable:** Type of learning method (interactive vs. traditional).
- **Dependent Variable:** Student performance (measured by test scores).

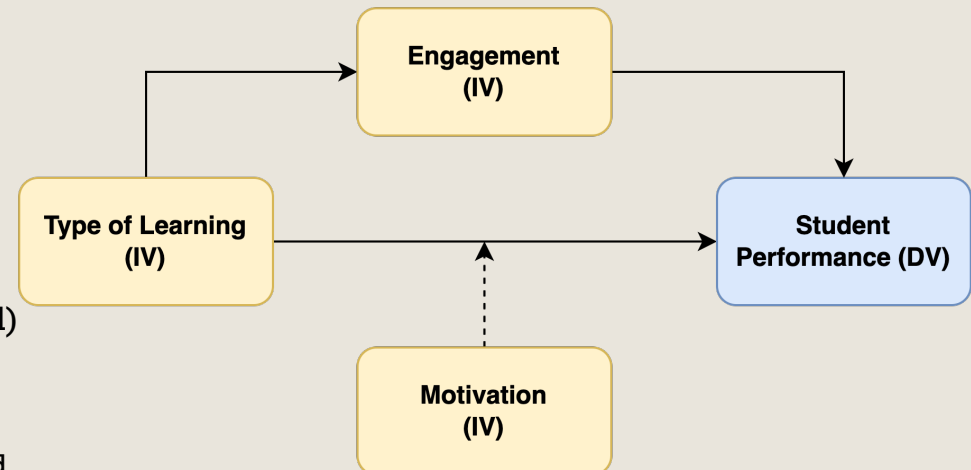


HOW TO DEVELOP A CONCEPTUAL FRAMEWORK?

- **Predictors** – IV that directly influence the dependent variable
- **Mediators** – IV that explain the mechanism through which predictors influence the dependent variable.
- **Moderators** – IV affect the strength or direction of the relationship between predictors and the dependent variable.
- While mediators depend on an IV, moderators do not.

Example in a Controlled Experiment:

- **Predictor: Learning method** (interactive vs. traditional) affects **student performance**.
- **Moderator: Student motivation** could influence **how strongly** learning method impacts performance.
 - Student motivation does not depend on the learning method
- **Mediator: Engagement** explains **why** interactive learning leads to better performance (higher engagement leads to better performance).
 - Student engagement depends on the learning method



EXERCISE: IDENTIFY VARIABLES AND RELATIONS BETWEEN THEM:

- **Predictors** – IV that directly influence the dependent variable
- **Mediators** – IV that explain the mechanism through which predictors influence the dependent variable.
- **Moderators** – IV affect the strength or direction of the relationship between predictors and the dependent variable.
- While mediators depend on an IV, moderators do not.

- Q1: You study how the agile approach affects the success of the projects. Among following, choose relevant variables, propose their measurable values and define relationships between them:

- Approach
- Project success score
- Size of the project
- Duration of the project
- Team constitution for the project
- Collaboration between team members
- Customer involvement
- Project technology stack

Draw a schema for your conceptual framework

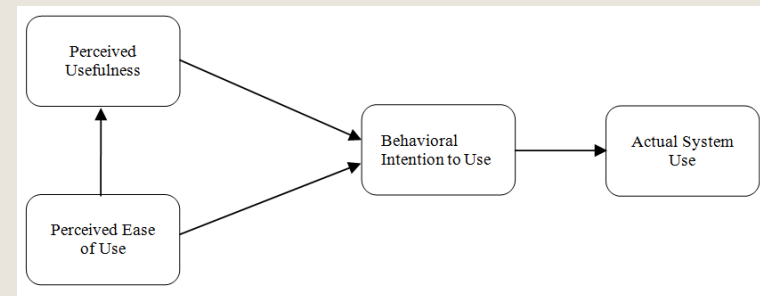
EXERCISE: MAKE HYPOTHESES

- **Predictors** – IV that directly influence the dependent variable
- **Mediators** – IV that explain the mechanism through which predictors influence the dependent variable.
- **Moderators** – IV affect the strength or direction of the relationship between predictors and the dependent variable.
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- Q2: Using the conceptual schema from your previous exercise, write down hypotheses you will test in your project

EXAMPLE: TAM THEORETICAL FRAMEWORK

- **Perceived Usefulness (PU):** The degree to which a person believes that using a particular system or technology will enhance their performance or productivity.
- **Perceived Ease of Use (PEOU):** The degree to which a person believes that using the technology will be free of effort.
- **Behavioral Intention to Use (BI):** This variable represents the user's intention to use the technology
 - is influenced by both **PU** and **PEOU**



EXAMPLE: TAM THEORETICAL FRAMEWORK

- **Predictors:**

- **PU** and **PEOU** directly influence **Behavioral Intention to Use**

- **Mediators:**

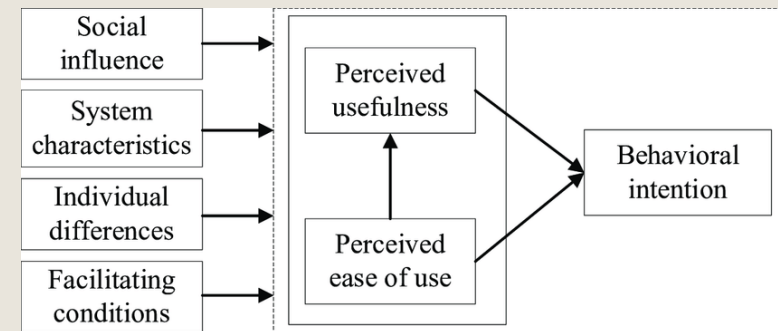
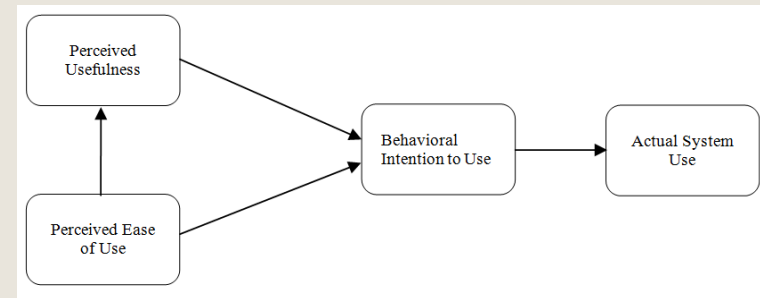
- **PU** mediates the effect of **PEOU** on **BI**.

- **Moderators** (not in original TAM):

- Factors like **experience** and **social influence** could moderate relationships between variables.

- **External factors (Antecedents)**

- explain **why** users perceive a system as useful or easy to use



HOW TO DEVELOP A CONCEPTUAL FRAMEWORK?

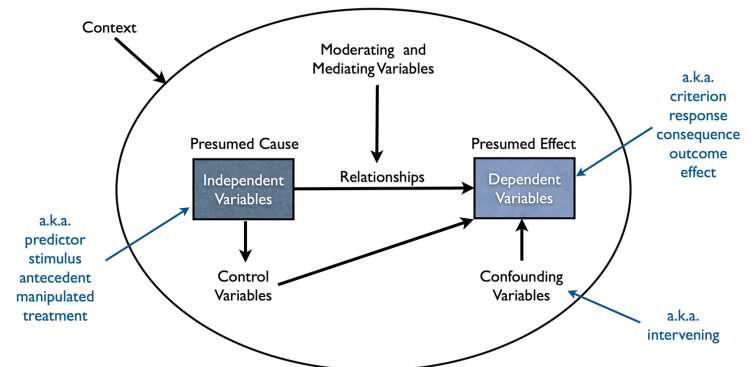
1. Analyse existing research and look for **specific concepts, variables and relationships between them**
2. Layout your conceptual framework in a form of a simple diagram
3. Identify dependent, independent, and influencing variables (e.g., moderator, mediator variables)
4. Make explicit (visualise) cause-effect or any other relevant relationships (known or hypothetical)
5. Add a narrative:
 - Express **Your RQ** and/or **Your Hypothesis** using these variables and relationships:
 - Is your research about examining/introducing/validating **new relationships? New variables?** ..

<https://www.edrawsoft.com/conceptual-framework.html>

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Conceptual Framework Fundamentals

Note 1: Two Benefits are Focusing and Bounding the Study



Note 2: Variables and Relationships are Identified from Theory and Experience

John Latham (c) 2005

Image source: drjohnlatham.com