



Research Methods for SCM

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Chapter 2 - Research in Operations Management

2.1.1 What is research?

Research and development is a term covering three activities: basic research, applied research, and experimental development.

- Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
- Applied research is original investigation undertaken in order to acquire new knowledge.
- Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices.

Key components are that the outcomes or outputs from research are new knowledge and/or new applications.

2.2.1 The aims and scope of research

Research may have different purposes: confirmation, falsification and exploration.

- **Confirmation:** quest to find the truth.
- **Falsification:** only needs to identify the rejection of an earlier hypothesis or theory.
- **Exploration:** there are always issues and problems that have not been studied before.

2.3.1 Type of research

Mode 1 research aims at knowledge development. **Mode 2** research aims at application of knowledge. Research can be further differentiated between explorative, descriptive, analytical, causal or normative.

2.3.2 Different roles for a researcher

Roles of a researcher:

- **Observer:** whether the researcher uses questionnaires, interviews, or participation, the researcher is supposed to be skilled in observing, which is key for collecting empirical data. Directly related to this, the researcher must

be good at recording the data that can be observed and it must be done in a systematic way.

- **Surveyor:** the researcher needs to be able to grasp large amounts of data and review it in a systematic way. Importantly, the researcher must be able to get a good understanding of the existing body of knowledge in the relevant areas.
- **Analyst:** The researcher should have analytical skills. This means abilities to break down data and classify it into categories. These should then be systematized in an orderly way so they turn into information.
- **Communicator:** The researcher must be skilled in communicating. Concepts and constructs need to be explained to the theoretical not-so-well-versed practitioner. Communicating demands listening skills even more than talking skills in order to hear what the person wants to say in addition to what they are saying and to make the person want to speak their mind.
- **Sounding board:** It is expected that the researcher can contribute with knowledge and comment on situations in the studied object.
- **Actor and other partner roles:** the study object may want help with doing certain things as a consequence of what is learnt in the ongoing research. This calls for a skill in the researcher and 'how-to' knowledge, not only 'what' knowledge.
- **Consultant:** based on the identified problems and developed knowledge, the researched object is likely to ask the researcher for advice on what should, or at least could, be done.
- **Clinician:** the most advanced interventionist role is when the researched is called for help. The whole idea is to cure the research object while at the same time use it as a database.

2.4 The research process

A generic process of research:

1. Identification of a problem or issue to research: reason/motivation of study
2. Literature review: know what already exist in knowledge
3. Specifying the aim, objective, or purpose of the intended research
4. Determine specific research questions: what do we want to know.
5. Choice of research approach and methods: how is the research question answered.

6. Development of a conceptual framework: what do you want to study
7. Data collection
8. Analysing and interpreting the data
9. Synthesizing and concluding
10. Evaluating the research and suggesting further research
11. Reporting and communicating the research findings

2.5.1 *The concept of knowledge*

Knowledge is about (1) beliefs and commitment, (2) action and (3) meaning.

Explicit knowledge is knowledge that can be captured, documented, transferred, shared and communicated easily. **Tacit knowledge** cannot be traced in documents and publications.

2.5.2 *Philosophy, truths, and realities*

The study of what exists and what hence can be said to be is called **ontology**. The difference in ontological perspectives will have effects on the researcher and the realities that the researcher sees.

2.5.3 *The logic of reaching a conclusion*

An important aspect in research is how arguments are built. An argument is a connected series of statements or propositions intended to provide support, justification, or evidence for the truth of another statement or proposition.

An argument is said to consist of:

- **Premises:** something that is put forward as a truth, but which is not proven.
- **Inference:** reasoning process between the conclusion and the premises, which translates the premises into the conclusion by formal argument and careful logic.
- **Conclusion:** the statement of the result of the analysis.

We differ between three generically different types of reasoning:

1. **Deductive** (top-down logic): the idea is to reach a logically certain conclusion from one or more statements. Logic says that if all of the premises are true then the conclusion must be true.

2. **Inductive** (bottom-up): the premises seek to supply strong but no absolute evidence for the truth of the conclusion.
3. **Abductive**: the logical inference goes from a conclusive observation to a theory that can lead to an explanation of the observation.

The logic of all three types of reasoning is built on the same three components. One component is **rule**: how the world is structured and functions. A second component is a **condition** that has been empirically observed: the database or the research material. A third component is the result or **conclusion**.

- Deductive: rule → condition → conclusion
- Inductive: condition → conclusion → rule
- Abductive: conclusion → rules → condition

2.5.7 Creating and developing knowledge

The empirical base may contain data, information and knowledge. Data are those facts that can be gathered and for which there are measures. When data are put in a system we say that we form information. With information somebody can be informed or enlightened. The information can then be put in a context and used, and, as a result, add experience. This experience enables an interpretation of the information, its applicability, effects and other strengths and weaknesses. As a result, knowledge is developed.

2.7.1 The concept of research quality

There are four particular requirements used in social sciences that are of relevance to OM research: construct validity, internal validity, external validity and reliability.

Construct validity means that the operational measures used to measure the constructs actually measure the concepts they are intended to measure.

Internal validity means that the study actually measures what it is meant to measure and that demonstrated relationships are explained by the factors described and not by other factors.

External validity means that the results are valid in similar settings outside the studied objects.

Reliability means that the study is objective in the sense that other researchers should reach the same conclusion in the same setting.

2.10.2 Ethics for researchers

Ethical issues for researchers deal with communicating benefits and risks, the protection of identify, privacy, obtaining informed consent, and much more. There are four areas of research ethics:

1. The principle of respect for human dignity
2. The principle of utility
3. The principle of precaution
4. The principle of justice

Checklist for ethics:

- Honesty
- Objectivity
- Integrity
- Carefulness
- Openness
- Respect for intellectual property
- Confidentiality
- Responsible publication
- Social responsibility
- Non-discrimination
- Legality
- Protect human subjects

Chapter 3 - The research process

3.1.1 What is theory?

A theory can be defined as a set of interrelated constructs, definitions and propositions that present a systematic view of phenomena by specifying

relationships among variables, with the purpose of explaining and predicting the phenomena. Theories explain facts and provide stories as to why phenomena work as they do.

Elements in a theory:

1. Conceptual definitions of the theory's constructs
2. Defined relationships between constructs
3. A limitation of the theory's domain, i.e. the boundary conditions within which the proposed relationships hold

First, theory defines all variables by answering the common questions of who and what. The domain specifies the conditions where the theory is expected to hold, thus answering the common questions of when and where. The relationship-building stage specifies the reasoning by explaining how and why variables are related. Finally, the predictive claims answer the questions of whether a particular event could or should occur.

3.1.2 Research products that are often confused with theory

Five elements that researchers often confuse with theory:

1. References are not theory
2. Data are not theory
3. Lists of variables or constructs are not theory
4. Diagrams are not theory
5. Hypotheses are not theory

Other terms that should not be confused with theory are:

- **Propositions.** There is a relationship between propositions and hypotheses. Both are related to theory, but are not theory in themselves. The difference is that hypotheses require measures whereas propositions involve concepts.
- **Model.** This is a way to operationalize a theory for empirical testing. Models do not always meet the requirements placed on theories. A distinction can be made between variance models and process models, thus between variance and process theories. Variance models are concerned with predicting levels of outcomes based on levels of predictor variables; they are thus concerned with cause and effect. Process models are concerned with explaining how outcomes develop over time.

- **Conceptual model.** Sets out in broad terms the definition of the particular problem to be solved, and it specifies the variables that will be used to define the nature of the problem.
- **Taxonomy.** Are used to classify things according to their similarities. Taxonomies are not theories, but they may represent excellent contributions to knowledge.
- **Framework.** Explains, either graphically or in narrative form, the main things to be studied and the presumed relationships among them.

3.1.3 Making theoretical contributions

How to make a contribution to theory:

- Researchers can make theoretical contributions by *adding or subtracting factors from an existing theory.*
- One fruitful but difficult way to develop theory is to address the why of the theory, that is, to *find alternative explanations for the occurrence of a phenomenon.*
- Researchers can also *address the domain limitations of the theory.*

Three broad themes underlie theoretical contributions. First, it is not sufficient to propose improvement addressing only a single element of an existing theory. Second, theoretical contributions should marshal compelling evidence, be it logical or empirical. Third, making theoretical contributions involves proposing remedies or alternatives.

3.1.4 Contributing to operations management knowledge

Since most relationships are complex, it is often fruitful to explore the moderators of variables. Moderators are factors that influence the strength of the direct effect between two independent variables.

3.1.5 Linking contributions to the maturity of knowledge

Theory in management research falls along a continuum from nascent to mature:

- **Nascent** theory proposes tentative answers to novel questions of how and why, often merely suggesting new connections among phenomena in situations where little or no previous theory exists.
- **Mature** theory presents well-developed constructs and models that have been studied over time with increasing precision by a variety of researchers, resulting in a body of knowledge that contains points of broad agreement.

There are two fundamental and equally valid ways in which research contributes to theory:

- Through **exploratory studies**, observing and identifying interesting, relevant and potentially counterintuitive phenomena that cannot be explained well enough by existing theory, and thus proposing these for further testing.
- Through **confirmatory studies**, empirically testing propositions in a given context so as to refute, amend, expand or confirm them as new theory and to define the realm of the theory's applicability.

Figure 3.1 (blz 53) shows this continuum.

3.1.6 Linking contributions to research philosophy

Ontology refers to our assumptions about the very essence of the phenomena under investigation.

Epistemology refers to our assumptions about the nature and status of knowledge, and about how one might begin to understand the world and communicate this understanding as knowledge to fellow human beings.

- Both ontology & epistemology → realist
- No ontology & epistemology → instrumentalist

3.3.1 Reasons for conducting a literature review

Performing a systematic literature review is important for several reasons. First, the literature helps to *define a researchable topic*. Second, existing literature can *inform our research*. We can find theories, models and frameworks that we can use in our own research. Finally, reviewing literature helps to *build critical researcher skills*.

3.3.6 The various ways to use existing literature

1. **Motivate and position the research.** The suggested research is motivated by reviewing the existing literature with a focus on understanding what research has already been conducted and what additions to this knowledge are needed.
2. **Create a framework for the research.** The framework can be seen as analogous to a pair of eyeglasses that the researcher puts on to study the chosen research topic.

3. **Support more hands-on 'action' in the research.** In action research, existing literature can guide efforts to understand a system through actively trying to change it.
4. **Interpreting and explaining research findings.** This use is particularly important in theory-developing case research.
5. **Discuss the research findings in relation to existing literature.** This step is critical in articulating and highlighting what the research contributes to the existing body of knowledge.

3.3.7 Ways of misusing literature

1. Only describe literature and not analyse it. A literature review involves more than merely describing and citing literature.
2. Simply review literature without using it.
3. Employ too many grand theories.
4. Usage of high-level theories is taken a guise for contributing to theory.

3.4.1 What research questions are not

Research purpose is a statement of what the research is trying to achieve and how this end is to be achieved.

Research aim is the purpose of doing something; what somebody is trying to achieve. This is interchangeable with research purpose, however, research aim may be used to express the desired end of the research, or what the research seeks to deliver. Research purpose on the other hand, can be used to describe what the research intends to achieve and how.

Propositions involve concepts whereas hypotheses require measures and specify in greater detail than propositions the relationship to be tested.

3.4.2 Types and forms of research questions

- Avoid research questions to which you could simply look up the answer.
- Avoid research questions the answers to which could only be speculative.
- Avoid research questions of a dead-end nature

Figure 3.4 (blz 67) illustrates the relationship between the type of research question and the maturity of existing knowledge.

3.4.4 Framing: using literature to construct the research question

Three main ways in which researchers can justify their research question by articulating gaps in existing literature.

1. **Neglect spotting:** here the researcher identifies a research topic where no research has been carried out.
2. **Confusion spotting:** here the researcher identifies some kind of confusion in existing literature by identifying previous research on the topic and concluding that available evidence is contradictory.
3. **Application spotting:** here the researcher identifies a new application in existing literature.

3.5.1 Methodological fit

The core of the notion of methodological fit is that there should be internal consistency among all the main elements of a research project.

The shaded areas in figure 3.6 (blz 70) illustrate when a particular research approach is likely to be used.

3.5.2 Philosophical position

The choice of research approach also needs to reflect the researcher's position with regard to the fundamental issues of ontology and epistemology (philosophical position). We will speak of a continuum with two endpoints: the positivist-researcher and the interpretative researcher.

The positivist researcher sees reality as objective: the world is external to the individual. The goal is to discover objective truth, providing results and conclusions that are replicable, verifiable and generalizable.

The interpretative researcher assumes that reality is socially constructed. Reality is not objective or 'out there', but exists as multiple local, intersubjective realities composed from subjective and objective meanings. The researcher's task is to produce descriptions of organizational members' meanings and definitions of a situation and to understand how they construct their reality.

3.5.3 Practical considerations in choosing a research approach

Finally, there are several practical considerations in choosing a research approach. Three such factors will be considered here: (1) access, (2) institutional factors and (3) skills and interests.

Chapter 4 - Surveys

4.1.1 What survey research is and for what purposes it can be used

In general, a survey involves the collection of information from individuals (web, email, telephone, interviews) about themselves or about the social units to which they belong.

Survey research can contribute to advancing scientific knowledge in different ways. Researchers often distinguish between exploratory, confirmatory and descriptive survey research.

Exploratory survey research takes place during the early stages of research on a phenomenon when the objective is to gain preliminary insight into a topic, and provides the basis for more in-depth survey research.

- Usually, there is no model and the concepts of interest need to be better understood and measured. In the very preliminary stages of inquiry, an exploratory survey can help researchers determine which concepts to measure in relation to the phenomenon of interest, the best way to measure them, and how to discover new facets of the phenomenon under investigation.
- An exploratory survey can be used to uncover or provide preliminary evidence of associations among concepts. Later, it can help researchers explore the validity boundaries of a theory. In the last two cases, models and measures are clearly more advanced than in the first case.
- Sometimes exploratory survey research is carried out using data collected in previous studies in order to gain new insights into a topic at low cost before embarking on a new ad-hoc survey. In such cases, survey research may be used to explore associations between concepts or the boundaries of validity of these associations.

Confirmatory (theory testing/explanatory) survey research takes place when knowledge of a phenomenon has been articulated in a theoretical form using well-defined concepts,

- Here, data collection is carried out with the specific aim of testing the concepts developed in relation to the phenomenon, the linkages hypothesized among the concepts and the validity boundaries of the model. Correspondingly, all of the potential sources of error have to be carefully considered.
- Sometimes, before embarking on a confirmatory survey to test a theory, OM researchers use secondary data to expose a theory to empirical tests that can allow for theory refinement and better design of the survey. This approach is different from exploratory survey research based on available data because the theory is already well formalized.

The use of secondary data can range from exploration to theory testing. They can be used alone or in combination with primary data.

Generating and testing a hypothesis can be achieved through the process of deduction (develop the model, formulate testable hypotheses, collect data, then test hypotheses) and through the process of induction (collect the data, formulate

new hypotheses based on what is known from the data collected and test them). These approaches can also be combined.

A new paradigm is proposed called **holistic construal** which is 'neither rigidly deductive (formalistic) nor purely exploratory. Rather it subsumes a process by which theories and hypotheses are tentatively formulated deductively, test on data and later, reformulated and retested until a meaningful outcome emerges'. This approach is intended to encompass aspects of both the theory-construction and theory-testing phases.

Descriptive survey research is aimed at understanding the relevance of a phenomenon and describing the incidence or distribution of the phenomenon in a population.

- Its primary objective is not theory development, but it can provide useful hints for both theory building and refinement through the facts it describes.

4.1.2 When to use survey research

Theoretical constraints associated with the state-of-the-art knowledge on a researched issue, and practical constraints associated with the kind of contribution the researcher intends to make, may limit survey applicability.

When the available knowledge on a research issue is very limited, then concepts are not well defined, measures are not available, lessons from previous empirical research may not be available, associations between concepts and explanations of these associations may be unknown etc.

Exploratory survey research and to a certain extent descriptive survey research are the available survey choices. These kinds of surveys complement the knowledge gained through case studies, overcoming the limited generalizability of cases and pushing towards the development of measures that can be used in different context. However, the highly structured questionnaires and the limited presence of open questions, which are necessary to perform good quantitative analyses, limit the exploration capability in comparison with case studies. Therefore, case studies and surveys should be seen as complementary in exploratory and theory-building research.

When knowledge on a topic is widely available and theory-testing research is to be carried out, then theory-testing survey research should be considered. It allows for testing whether the hypothesized relationships or differences hold in different contexts. This generalization capability is one of the main strengths of the survey method, together with the relatively limited effort required to collect and analyse data compared to other methods.

However, if the aim of the researcher is to investigate the mechanisms that explain the hypothesized relationships, then survey research may present some limitations on its own, so using it in combination with case studies may represent a better methodological alternative.

Furthermore, if the researcher aims to give detailed prescriptions for practice, then survey research falls short on precision or simply may not be feasible due to the need for detailed information on the context and the relevant variables. In this case, simulation or mathematical modelling is preferable, although a survey may help provide parameters or other empirical data for use.

In short, a survey is suitable when knowledge of the phenomenon is not too developed, when generalization is an important intended contribution, when the variables and the context can be detailed and when the empirical evidence sought concerns 'how variables are related', 'where the relations hold' and 'to what extent a given relation is present'.

4.1.3. Which OM topics have been researched by means of survey

No previous use of survey research may suggest the existence of severe constraints, while previous use may suggest that survey research is applicable, albeit with careful scrutiny of previous experience.

4.1.4 How survey research has been used in OM

Improvement opportunities relate to several aspects of survey research and increase in number, detail and required effort as time passes. However, they may be grouped around the following general issues:

- Framing the survey research in terms of theoretical contributions
- Use of scientific measurement instruments, possibly shared across OM researchers
- Rigour in the survey design and in the execution phases
- Clarity and explicitness in reporting information on the survey execution

4.2 The survey research process

Survey research includes a number of related sub-processes: the process of translating the theoretical domain into the empirical domain; the design and pilot-testing processes; the process of collecting data for theory testing; the data-analysis process; and the process of interpreting the results and writing the report.

Figure 4.1:

1. Link to the theoretical level
2. Design
3. Pilot test
4. Collect data
5. Analyse data
6. Generate report

Exploratory survey research:

- Can be carried out without a theoretical model. However, defining a sketchy framework that at least classifies the variables measured will improve the quality of the survey and will increase the contribution of the subsequent data analysis and interpretation.
- Uses more descriptive analysis and less model-based analyses. It may perform many different trials to gather new insights from the available data.
- A proposed model can be the result of the data analysis.
- Does not put stringent constraints on measurement. Single-item perceptual measures may be acceptable if knowledge on that issue is limited.

Theory-testing survey research:

- Puts great importance on the model, since it is not theory testing if it is not based on a theoretical model from the outset.
- Carries out previously planned analyses and even post-hoc analyses to better interpret the obtained results.
- Relational analyses are used more than descriptive analyses.
- Eventually, the tested model can be modified and retested.
- Requires extreme rigour in all analyses.

Descriptive survey research:

- Does not necessarily require a model: only a rigorous definition of the concepts to be measured is required. Again, the availability of a model will facilitate a meaningful presentation of the results and a reduction in the length of the questionnaires, and will improve the usability of the resulting data for other purposes.

- Uses descriptive analyses; however, it can also use data reduction techniques to present a more parsimonious view of the phenomenon.
- Requires rigour in representing the population under study, but less rigour than theory-testing in terms of measurement.

→ The more well developed the model, the better for any kind of survey research, although the minimum acceptable level of development differs.

4.3 What is needed prior to survey research design?

Before starting survey-based research, the researcher should have a clear idea of what the problem is about and should discuss it in depth. Second, the researcher should map the problem in the existing literature in order to be cognizant of what is already known and what is still unknown. Third, the researcher should clarify the intended contribution of the research.

In exploratory survey research, a careful consideration of the available knowledge allows the researcher to perform the most rigorous survey permitted by the state-of-the-art knowledge on the phenomenon. It may pose several problems with regard to framing the research, as little support is provided by the available literature.

In theory-testing survey research, this facilitates the reuse of measures, explanations and previous results, thus enabling surveys to do not suffer the limitations encountered in previous studies. This is based on more established knowledge and, therefore, the focus of the research is easier to communicate clearly.

4.3.1 The theoretical model

A conceptual model must be established and can be achieved by providing:

- Construct names and nominal definitions
- Propositions: presentation and discussion of the role of the constructs, the important linkages between them and an indication of the nature and direction of the relationships.
- An explanation: why would you expect these relationships
- Boundary conditions: definition of the conditions under which the researcher might expect these relationships to hold; these include the identification of the level of reference of the constructs and statements of their relationships.

Many concepts have been defined ambiguously and the scope of it has so widened in use that they are vague and overlap with other concepts. A different problem is represented by terms that are used with different meanings. Different meanings lead to different operationalizations and different relationships to other concepts.

Without an agreement regarding what a concept means, it is meaningless to assess face validity. Further, if there are two concepts that overlap, it would be meaningless to test for discriminant validity. Finally, if a performance outcome is placed within the definition of a practice, it is meaningless to test the predictive validity of a measure of this practice by using the same performance as criterion variable.

Guidelines conceptual definitions: Table 4.5

It is recommended that a single piece of research that uses data collected through a multipurpose survey pursue only one objective (exploratory/descriptive/theory-testing). It is also recommended that theory testing and descriptive purposes be investigated in depth before the survey is designed so that the sample and operationalizations of the variables are satisfactory.

4.3.2 From the theoretical model to the hypotheses

Once the constructs, their relationships and the boundaries of validity of these relationships have been articulated, then the propositions that specify the relationships among the constructs have to be translated into hypotheses that relate empirical indicators.

Before the researcher can talk about how to collect data, it is necessary to:

1. Define the unit of analysis corresponding to the level of reference of the theory.
2. Provide and test the operational definitions for the various constructs.
3. Translate the propositions into hypotheses.

4.3.2.1 Defining the unit of analysis

The unit of analysis refers to the level of data aggregation during the subsequent analysis. It is necessary to determine the unit of analysis when formulating the research questions. Data collection methods, sample size and even the operationalization of constructs may sometimes be determined or guided by the level at which the data will be aggregated at the time of analysis.

When the level of reference is different from the unit of analysis, the researcher will encounter the cross-level inference problem: the problem of collecting data at one level and interpreting the result at a different level.

4.3.2.2 Developing and testing the operational definitions

The first problem the researcher faces is to translate the theoretical concepts into observable and measurable elements. If this work is not done well, the nominal definitions will not match the operative definitions. As a result, the rest of the research cannot be trusted.

The list of observable elements in each construct facet should be developed before writing the items/questions that constitute the measure. Separating the two tasks will help the researcher focus on the content instead of on the wording.

The action of reducing abstract constructs so that they can be measured presents several challenges: aligning the theoretical concepts and the empirical measures, choosing between objective and perceptual questions and choosing the number of questions for the construct for a dimension of a construct or for an observable element.

When constructs are subjective and have multiple facets, it is recommended that operational definitions that include multiple elements be used. In contrast, when objective constructs are considered, a single direct question would be sufficient.

When the operational definition has been developed, the researcher should test it for content validity. The content validity of a construct measure can be defined as the degree to which a measure's items represent a proper sample of the theoretical content domain of a construct.

Two conditions are to be satisfied by a measure's items in order to confirm content validity. First, each item should fall within the concept's theoretical domain. Second, the set of items should capture the different facets of a construct in a balanced way. If the items are too similar to each other, then important facets of the constructs are probably not covered. If the items touch only one aspect of a multifaceted construct, then the measure does not span the entire domain of the construct.

Evaluating the face validity of a measure (assessing whether the measure 'at face value' seems like a good translation of the theoretical concept) can indirectly assess its content validity.

In order to highlight the importance of making such an assessment before heavy data collection, a new measurement instrument is developed as a two-stage process.

1. Perform item generation and purification refinement prior to developing the questionnaire and field study.
2. Focus on the survey instrument, data collection, confirmatory analysis and item refinement.

For each i^{th} candidate item in the measure, the content validity ratio (CVR) is calculated: $\frac{n_e - \frac{N}{2}}{\frac{N}{2}}$, where n_e is the number of SMEs indicating the measurement item i as 'essential' and N is the total number of SMEs in the panel.

Another approach to assessing face validity is to give judges both the list of items and the definition of each construct or construct dimension. Subsequently, judges are asked to map the items into the construct definitions.

This phase of checking for content validity may prevent subsequent problems with reliability and convergent/discriminant validity.

If multiple constructs are investigated, the use of Q-sort procedure may help to identify the convergent/discriminant capability of a given set of items. If an item is mapped into one construct and by other into another, it means that the item does not contribute to discriminating between the two constructs. If the researcher adds an additional category (other constructs), and an item is mapped into this category, then the item may be problematic for the assessment of convergent validity, which will be performed after data collection.

4.3.2.3 Stating hypotheses

A hypothesis is a logically conjectured relationship between two or more variables, expressed in the form of testable statements. A hypothesis can also test whether there are differences between two groups with respect to any variable or variables.

Hypothesis can be in either the propositional or the if-then statement form. If terms such as positive or negative are used in stating the relationship between two variables or in comparing two groups, the hypotheses are directional. When there is no indication of the direction of the difference or relationship, they are called non-directional and are used when the relationships or differences have not been explored previously, or when there are conflicting findings.

The null hypothesis is a proposition that states a definitive, exact relationship between two variables.

4.4 How a survey should be designed

Survey design includes all of the activities that precede data collection. In this stage, the researcher should consider all the possible shortcomings and difficulties

and should find the right compromise between rigour and feasibility. Overview and order are necessary to prevent subsequent problems.

4.4.1 Considering constraints and information needs at the macro level

The researcher should consider the suitability of the survey methods and the overall feasibility of the research project. Time, costs and general resource requirements can constrain a survey project, e.g. forcing a less expensive type of survey. Other possible constraints are the access to the population and the feasibility of involving the right informants.

There is a trade-off between time and costs constraints and minimization of four types of errors:

1. **Sampling error:** a sample with no capability of representing the population excludes the possibility of generalizing the result beyond the original sample.
2. **Measurement error:** data derived from the use of measures that do not match the theoretical dimensions, or are not reliable, make any test meaningless.
3. **Statistical conclusion error:** when performing statistical tests, there is a probability of concluding that the investigated relationship does not exist even when it does exist.
4. **Internal validity error:** when the explanation given of what has been observed is less plausible than rival explanations, then the conclusions can be considered erroneous.

To evaluate the tightness of the constraints adequately, the researcher should identify the main information needs, which flow from the stated hypotheses and, ultimately, from the various purposes of the study. Finally, a study may not aim to only test a theory, but also to perform additional exploratory analyses, while reducing the cost of the research and increasing the speed of generating knowledge.

4.4.2 Planning activities

Carefully planning of the survey research is crucial to preventing problems and assuring the quality of the research process. For this reason, the design phase should be detailed and should be followed by a pilot-testing phase aimed at assuring that the survey instrumentation and procedures are adequate.

Decisions made at the beginning of the process affect choices available at later steps. Constraints and limitations in the later steps should be considered in the earlier steps. For these reasons, major decisions about data collection and the time

horizon must always be made in prior to selecting a sample and designing and constructing the questionnaire and other material. It is important to match the capabilities and the limitations of the data processing methods with the sampling and instrumentation.

4.4.3 Sample

Population refers to the entire group of people, firms, plants or things that the researcher wishes to investigate.

Element is a single member of the population.

Population frame is a list of all elements in the population from which the sample is to be drawn.

Sample is a subset of the population: it comprises some members selected from the population.

Subject is a single member of the sample.

Sampling is the process of selecting a sufficient number of elements from the population so that by studying the sample, and understanding the properties or the characteristics of the sample subjects, the researcher will be able to generalize the properties or characteristics to the population elements.

Poor sample design can constrain the application of more appropriate statistical techniques and the generalizability of the results. Two issues should be addressed when designing the sample: randomness and sample size. Randomness is associated with the ability of the sample to represent the population. Sample size is associated with the requirements of the statistical procedures used for assessing the measurement quality and testing the hypothesis.

4.4.3.1 Population frame

The classification of the industry under investigation is an important aspect of defining the study population. To facilitate control of industry effects, a good practice is to consider 4-digit ISIC codes when building the population frame and then the research sample. This issue should not be underestimated, since controlling industry effects can compensate for variability between industries.

Other than industry, another important variable to control for is company size: the number of employees and sales are easily available and can be incorporated in the sample selection process.

The researcher has to be creative in identifying/reaching the population elements and in describing the considered population.

4.4.3.2 Sample design

Sample designs can be grouped into two families: probabilistic and non-probabilistic sampling. In **probabilistic sampling**, the population elements have some known probability of being selected, differently from **non-probabilistic sampling**.

- Probabilistic sampling is used to assure the representativeness of the sample when the researcher is interested in generalizing the results. When time or other factors are considered by the researcher to be more important than generalizability, then non-probabilistic sampling is usually chosen.

Stratified random sampling is a very useful type of sampling, since it provides more information for a given sample size.

- Stratified random sampling involves the division of the population into strata and a random selection of subjects from each stratum. Strata are identified on the basis of meaningful criteria like industry type, size, performance or other categories. This procedure ensures high homogeneity within each stratum and heterogeneity between strata.
- Stratified random sampling allows the comparison of population subgroups and allows control for factors like industry or size, which very often affect results.

4.4.3.3. Sample size

Sample size is a complex issue and is linked to the significance level and the statistical power of the test, and also to the size of the researched relationship.

When making a statistical inference, the researcher can make either a Type I error (reject the null hypothesis H_0 when it is true) or a Type II error (H_0 is not rejected when the alternative hypothesis H_a is true).

- The probability of making a Type I error (α) is called the significance level. The null hypothesis is rejected if the observed **significance level** (p-value) is less than the chosen value of α .
- The probability of a Type II error is β , and the **statistical power** is equal to $1-\beta$. A high statistical power is required to reduce the probability of failing to detect an effect when it is present. A low statistical power leads to a study that is not able to detect large size effects, while high power lead to committing unnecessary resources in order to detect only trivial effects.
- A balance between the two types of errors is needed because reducing any one type of error increases the probability of the other.

- The required sample size increases while increasing the statistical power, and/or decreasing the significance level, and/or decreasing the size of the effect researched.

4.4.4 Data collection method

In survey research, the main methods used to collect data are interviews and questionnaires. Interviews may be structured or unstructured and can be conducted face-to-face or over the telephone.

Questionnaires can be administered personally, by telephone or through the web, and can be posted or e-mailed to the respondents.

The best method cannot be chosen without taking into account the needs of the specific survey, time, cost and resource constraints.

Postal survey: questionnaires are printed and sent by post.

- Advantages: inexpensive, can be completed at the respondent's convenience, can be prepared to give an authoritative impression, ensure anonymity, reduce interviewer bias, respondent has more time to consider his/her responses.
- Disadvantages: lower response rate, involve longer time periods, more effective by self-selection, lack of interviewer involvement, lack of open-ended questions.

Face-to-face survey: the interviewer solicits information directly from a respondent during personal interviews.

- Advantages: flexibility in sequencing the questions, details and explanations; possibility of administering highly complex questionnaires; improved ability to contact hard-to-reach populations; higher response rates; increased confidence that data collection instructions are followed.
- Disadvantages: higher cost; interviewer bias; respondent's reluctance to cooperate; greater stress for both parties; less anonymity.

Telephone survey: involve collecting information through the use of telephone interviews.

- Advantages: rapid data collection; low cost; anonymity; large-scale accessibility; higher confidence that instructions are followed.
- Disadvantages: less control over the interview situation; less credibility; lack of visual materials.

Online questionnaires (email/website):

- Advantage: minimal cost.

- Disadvantage: problem in sampling and controlling the research environment

The increase use of the web survey technique makes these surveys less problematic in terms of response rate and non-response bias.

4.4.5 The measurement instrument

One of the main characteristics of the survey is that it relies on structured instruments to collect information. When the content of the measure is decided, several tasks remain in order to develop the measurement instrument:

- Defining how the questions are to be formulated to collect the information on a specific concept
- For each question, deciding the scale on which the answers are to be placed.
- Identifying the appropriate respondent(s).
- Putting the questions together in questionnaires that facilitate and motivate responses from the respondent(s).

4.4.5.1 Wording

The researcher should ensure that the language of the questionnaire is consistent with the respondents' level of understanding. The researcher also has to choose between open-ended or closed questions. Closed questions facilitate quick decisions and easy information coding, but the researcher has to ensure that the alternatives are mutually exclusive and collectively exhaustive. Another choice in formulating the questions is a mix of positively and negatively worded questions in order to minimize the tendency in respondents to circle the points mechanically towards one end of the scale.

Ambiguity in questions and leading questions should be avoided and loaded questions (emotional) should be eliminated. Questions should also not be worded to elicit socially desirable responses.

4.4.5.2 Scaling

The scale choice depends on the ease with which the respondent can respond to items and the ease with which the subsequent analyses can be performed. There are four basic types of scale: nominal, ordinal, interval and ratio (table 4.9 - blz 119).

As the sophistication increases, so also does the information detail, the ability to differentiate the individuals and the flexibility in using more powerful tests.

Non-metric data includes attributes, characteristics, or categorical properties that can be used to identify or describe a subject. → nominal/ordinal.

Metric data measurement is made so that subjects may be identified as differing in amount or degree. → interval/ratio.

4.4.5.3 Respondent identification

The researcher should identify the appropriate informations for each set of information required. Increasing the number of respondents increases the probability of receiving only some completed questionnaires, leading to incomplete information, which can impact the results of relational studies. On the other hand, answers from respondents who are not knowledgeable cannot be trusted and increase random or even bias error.

A form of triangulation can be used by having multiple respondents for the same questions. These strategies reduce the common method/source variance.

4.4.5.4 Rules of questionnaire design

Some basic rules of courtesy, presentation and readability are essential for successful data collection. An attractive and neat questionnaire with an appropriate introduction, clear instructions and a well-formatted set of questions will make it easier for the respondents to answer the questions.

Mixing items that belong to different measures contributes to avoiding stereotype answering. The presence of reversal questions keeps attention high. The length of the questionnaire affects the response rate and attention in filling in the questionnaire.

Visual aids reduce the risk of misinterpretation of the question or instructions.

4.4.6 Approaching companies and respondents

To increase the probability of successful data collection, the researcher should plan the execution of the survey research carefully and should provide detailed instructions on the following:

- How the sampling units are going to be approached
- How the questionnaires are going to be administered

It is important that researchers find ways to obtain collaboration of companies and specific respondents. The researcher should:

- Reward the respondent by showing positive reward etc.

- Reduce the cost to the respondent by making the task appear brief etc.
- Establish trust by providing a token of appreciation in advance.

The contact strategy should take into account that a questionnaire will be lost or delivered wrong if the name of the respondent is not known.

4.5 Pilot testing the questionnaire

4.5.1 Purpose and modality of pilot testing

The researcher has to examine the measurement properties of the survey questionnaires and the viability of the administration of these surveys.

The pre-test of a questionnaire should be done by submitting the 'final' questionnaire to three types of people: colleagues, industry experts and target respondents.

- The role of the colleague is to test whether the questionnaire accomplishes the study objectives.
- The role of industry experts is to prevent the inclusion of some obvious questions that might reveal the investigator's ignorance in some specific areas.
- The role of target respondents is to provide feedback on everything that could affect whether and how the target respondents answer the questions.

Experience has shown that the best way to pre-test a self-administered questionnaire is to proceed in two phases, each with completely different but complementary objectives.

1. The researcher fills in the questionnaire with a group of potential respondents or when visiting three or four potential respondents. The researcher should be present, observing how respondents fill in the questionnaire and recording their feedback.
2. The researcher carries out a small pre-test sample to test the contact-administration protocol, to gather data for performing an exploratory assessment of the measurement quality and to obtain information to better define the sample and the adequacy of the measures in relation to the sample. In this phase it may also be possible to observe the effects of missing data and non-response bias in order to define appropriate countermeasures.

In sum, the pilot test should resemble as closely as possible the actual survey that will be conducted for theory testing.

4.5.2 Handling non-respondents and non-response bias

Non-respondents alter the sample frame and therefore can lead to a sample that does not represent the population, even when the sample was adequately designed for that purpose. Non-respondents can limit the generalizability of the results. In the pilot-testing phase, the researcher should identify a way to address this problem.

The non-response effects on results can be addressed in two ways:

1. By trying to increase the response rate
2. By trying to identify the non-respondents in order to control whether they are different from respondents.

Response rates can be increased when a subsequent follow-up programme is applied, such as sending reminders. A phone call is more useful, since it makes it possible to:

- Confirm that the target respondent has received the questionnaire.
- Establish a personal contact
- Take some time to explain the research
- Help the respondent
- Gather some information about non-respondents

Researcher should keep track of non-respondents to understand whether and how much bias has been introduced. The researcher can investigate reasons that prevent target respondents from responding and they can also check for differences between the first wave of respondents and later returns.

The researcher could trade sample size for sample representativeness by following two opposite strategies:

1. Devote great effort for a limited number of contacts → higher response rate, known sample bias and higher data reliability and completeness.
2. Devote little effort for a great number of contacts → large samples, unknown representativeness and data quality.

4.5.3 Inputting and cleaning data

The first step in processing data usually entails transcribing the data from the original documents to a computer database. Some errors might occur that arise from two situations:

1. The transcriber misreads the source document, but correctly transcribes the misinterpreted data

2. The transcriber reads the source document correctly, but incorrectly transcribes the data.

Independent verification of any transcription that involves reading and interpreting hand-written material is therefore advisable.

When an error is detected, the researcher may choose between the following options, singly or in combination, to resolve it:

- Consult the original interview/questionnaire to determine if the error is due to incorrect transcription.
- Contact the respondent again to clarify the response or obtain missing data.
- Estimate or impute a response to resolve the error, using various imputation techniques.
- Discard the response or designate it as bad or missing data.
- Discard the entire case.

Optical scanning and web-based questionnaires allow automatic data inputting, thus reducing errors. Computer-assisted personal interviewing (CAPI) or telephone interviewing (CATI) allows interviews to be completed with answers entered directly into databases, thus reducing intermediate steps and errors. The data input programs can perform checks on the data.

4.5.4 Assessing the measurement quality

4.5.4.1 Importance of ensuring and assessing measurement quality

Measurement errors represent one of the major sources of error in survey-based research and should be kept at the lowest possible level. Furthermore, as measurement errors affects the results of survey-based research, it should be assessed not only during the research, but also reported in the report/articles derived from the research.

The most crucial aspect related to measurement quality concerns the measurement of complex constructs by multi-item measures.

4.5.4.2 Measure quality criteria

The goodness of measures is evaluated in terms of validity and reliability. **Validity** is concerned with whether we are measuring what we intend to measure, while **reliability** is concerned with the stability and consistency in measurement scores.

Lack of validity introduces a systematic error (bias), while lack of reliability introduces a random error.

Reliability indicates dependability, stability, predictability, consistency and accuracy, and refers to the extent to which a measuring procedure yields the same results in repeated trials.

The four most common methods used to estimate reliability are:

1. Test-retest method:
 - a. Procedure: It calculates the correlation between responses obtained through the same measure applied to the same respondents at different points of time.
 - b. Meaning: It estimates the ability of the measure to maintain stability over time. This aspect is indicative of measure stability and low vulnerability to change in uncontrollable testing conditions and in the state of the respondents.
2. Alternative form method
 - a. Procedure: It calculates the correlation between responses obtained through the different measures applied to the same respondents at different points of time.
 - b. Meaning: It assesses the equivalence of different forms for measuring the same construct.
3. Split halves method
 - a. Procedure: It subdivides the items of a measure into two subsets and statistically correlates the answers obtained at the same time to them.
 - b. Meaning: It assesses the equivalence of different sets of items for measuring the same construct.
4. Internal consistency method:
 - a. Procedure: It uses various algorithms to estimate the reliability of a measure from measure administration at one point in time.
 - b. Meaning: It assesses the equivalence, homogeneity and inter-correlation of the items used in a measure. This means that the items of a measure should hang together as a set and should be capable of independently measuring the same construct.

The most popular test within the internal consistency method is the Cronbach's coefficient alpha.

Construct validity refers to the degree to which a measure represents and acts as the concept being measured. While content validity refers to the degree to which the meaning of a set of items represents the domain of the concept under investigation, construct validity refers to the degree to which the scores obtained from using a set of items behave as expected.

→ Without content validity, it is impossible to have construct validity.

Construct unidimensionality is the first property to check when assessing construct validity. It should even precede the assessment of reliability. A measure must satisfy two conditions in order to be considered unidimensional.

1. An empirical indicator must be significantly associated with an underlying latent variable.
2. It can be associated with one and only one latent variable.

Assessing unidimensionality can be performed both with exploratory factor analysis and with confirmatory factor analysis. Factor analysis can be performed on items belonging to a single summated scale or on items of several summated scales.

There are two aspects of construct validity:

- **Convergent validity:** refers to the degree to which multiple attempts to measure the same concept are in agreement. The idea is that scores obtained by two or more measures of the same thing co-vary highly if they are good measures of the same thing.
- **Discriminant validity:** refers to the degree to which measures of different concepts are distinct. The idea is that, if two or more concepts are distinct, then goods measures of these concepts should not correlate too strongly.

Convergent and discriminant validity can be tested through the multitrait-multimethod (MTMM) matrix method or the confirmatory factor analysis (CFA) method.

Criterion-related validity: when an instrument is intended to perform a prediction function, validity depends entirely on how well the instrument correlates with what it is intended to predict (a criterion). Criterion-related validity is established when the measure differentiates subjects on a criterion it is expected to predict. Establishing concurrent validity or predictive validity can do this.

- Concurrent validity is established when the scale discriminates subjects that are known to be different.
- Predictive validity is the ability of the measure to differentiate among subjects with respect to a future criterion.

When a test is conducted to assess an aspect of construct validity or criterion-related validity does not support the expected result, then either the measurement instrument or the theory could be invalid.

4.5.4.3 Steps in assessing validity and reliability

If a previously developed measure is used in a modified form, then the quality of the measure should be re-assessed and contrasted with the one of the original measures.

Assessment of measure quality takes place at various stages of survey research: before data collection; in pilot testing; in ad-hoc analyses to validate the measure; and finally after data collection, for hypothesis testing. The elimination of an item requires the researcher to return to content validity assessment and redo all of the subsequent tests.

4.6 Advancements in theory formalization and survey design

One important decision in developing and testing a measure is that of conceptualizing and formulating a construct as formative or reflective.

- Reflective construct: then the latent variable determines the construct indicators (items are being caused by the latent variable).
- Formative construct: then the indicators determine the latent variable (items causing the latent variable).

Researchers have mainly adopted covariance-based structural equation modelling (CBSEM) methods to assess the measurement quality for reflective constructs.

Researchers agree that the criteria used to evaluate reflective constructs should not apply to formative constructs.

When having high heterogeneity, measurement equivalence should be assessed before pooling data or before comparing subgroups.

The idea behind control variables is that they essentially remove the variation explained by a predictor variable that has some readily identifiable alternative explanation.

4.7 Survey execution

4.7.1 Redoing activities at a larger scale

At the end of pilot testing, the researcher either can proceed with theory testing or will have to revise the survey questionnaires, the survey administration process or both.

A researcher should move to the execution phase only when all relevant issues have been addressed. The researcher now has to repeat the pilot-testing activities with a large sample:

- Approaching companies/respondents and collecting data
- Controlling and reducing the problems caused by non-respondents
- Performing data input and cleaning
- Treating missing data
- Assessing measurement quality
- Providing feedback to respondents → should be done to motivate their present and future involvement.

4.7.2 Handling missing data

Missing data cannot be overlooked, as they have a negative impact on statistical power and may cause biased estimates in several ways. Two questions must be addressed concerning missing data.

1. How much of the data is missing? As the percentage of missing data increases, not only does the statistical power decrease dramatically, but the different techniques for treating missing data lead to increasingly different results.
2. Whether or not is the pattern of missing observations random? One method of assessing randomness is to split the set of observations into two subsets: one with missing data for the variable, and the other with valid values for the variable. If patterns of significant difference were found between the two subsets on other variables of interest, this would indicate that missing data are not the result of a random process.

The best approach to deal with missing data is to prevent their occurrence in the first place by increasing respondent involvement, giving clear instructions and supporting and recalling respondents to ensure completeness after administering the questionnaire.

When data is missing, three broad strategies can be adopted:

1. Deletion
 - a. Listwise: an entire observation is deleted if it has a missing value in one variable.
 - b. Pairwise: the observation is deleted only from those statistical analyses that require the missing data.

- c. A deletion strategy generally leads to unbiased results but decreases statistical power.
2. Replacement based on estimation: involves estimating the missing observation, subsequently replacing the missing data with the estimate and proceeding with a statistical analysis of the data set.
 - a. Mean-based
 - b. Regression-based
 - c. Model-based
 - d. Hot-deck imputation: a missing value is replaced with the actual score from a similar case in the amended data set.
3. Model-based strategy: provides explicit modelling of missing data, thus allowing an open analysis and critique. It is the best solution with missing data that is non-random.

4.8 Data analysis and interpretation of results

Data analysis can be divided into two phases: preliminary data analysis and hypothesis testing. The objective is to provide some information to complete the overview of the theory-testing survey research process.

4.8.1 Preliminary data analysis

In order to acquire knowledge about the characteristics and properties of the collected data, some preliminary data analyses are conducted, usually before performing measurement quality assessments or testing the hypotheses. This gives a preliminary indication of how well the coding and inputting of data have been done, how good the scales are and whether poor content validity or systematic bias should be suspected. Before testing the hypotheses, it is useful to check the assumptions underlying the tests and to get a feel for the data, in order to better interpret the results of the tests.

The discovery of errors, outliers, absence of normality and absence of variance homogeneity leads to a number of actions. These actions may entail modification of the data to make them suitable for subsequent analyses. Outliers bias the mean and inflate the standard deviation and can lead both to Type I and Type II errors. The knowledge acquired in a preliminary data analysis may influence the discussion of the results and the conclusions.

Preliminary data analysis is performed by checking central tendencies, dispersions, frequency distributions and correlations. It is good practice to calculate:

- The frequency distribution of the demographic variables

- The mean, standard deviation, range and variance of the other dependent and independent variables
- An inter-correlation matrix of the variables

Table 4.13 gives some of the most frequently used descriptive statistics in preliminary data analysis (blz. 143). Table 4.14 presents some of the most common techniques available in statistical packages to perform the preliminary data analysis (blz 144).

4.8.2 Analysing data for hypothesis testing

Significant tests can be grouped into two general classes:

- **Parametric:** are considered more powerful because their data are typically derived from interval and ratio measurements whose likelihood model is known, except for some parameters.
- **Non-parametric:** are used with nominal and ordinal data.

It should be remembered that some parametric tests are not affected seriously by violations of assumptions, while for others, a departure from assumptions may threaten results validity. Non-parametric tests have fewer and less stringent assumptions. When the population distribution is undefined or violates the assumption of parametric tests, non-parametric tests must be used.

The following three questions should be considered in order to choose the significance test:

1. Does the test involve one sample, two samples, or k samples?
2. If two or k samples are involved, are the individual cases independent or related?
3. Is the measurement scale nominal, ordinal, interval or ratio?

Table 4.15 gives examples of some parametric tests (blz. 145) and table 4.16 shows non-parametric tests (blz. 146). Table 4.17 presents some of the more established multivariate techniques (simultaneous analysis of more than two variables) (blz. 147).

4.8.3 Linking measure quality assessment to hypothesis testing

Procedures to assess measures of validity-reliability are applied independently of statistical procedures to test causal hypotheses. Measurement and method error can cause 'spurious confirmation of inadequate theories, tentative rejection of

adequate theories, and/or distorted estimates of the magnitude and relevance of actual relationships.

4.8.4 Interpreting results

When interpreting the results, the researcher moves from the empirical to the theoretical domain. This process implies considerations of inference and generalization.

In making an inference on relations between variables, the researcher could incur a statistical error or an internal validity error.

- The statistical error can be taken into account by considering the issues of statistical power, significance level, sample size and effect size.
- An internal validity error mistakenly attributes the cause of a variation to a dependent variable.

Even when data-analysis results are consistent with the theory at the sample level, the researcher should be careful about inferring that the same consistency holds at the population level (sampling, response rate, response bias). A further aspect of results interpretation concerns the discussion of potential extension of the theory to other populations. The degree to which the study's results can be generalized across populations, settings and other similar conditions constitutes the external validity of the study.

4.9 Information that should be included in articles

In an article reporting the results of a survey-based study, the researcher should provide all of the information (Table 4.18 - blz. 149) that allows reviewers and readers to:

- Understand what has been done
- Critically evaluate what the work has achieved
- Replicate the work or compare the results with similar studies

Table 4.18 is necessary if the purpose of the article has a theory-testing purpose, but this information is also generally useful when the article is of a descriptive or exploratory nature.

An honest and capable researcher should mention limitations, thus paving the way to future research and avoiding definitive acceptance of results whose validity is, to some extent, questionable.

4.10 Ethical issues in survey research

The implications for the respondents and for the organizations with regard to lack of privacy and/or confidentiality may be very severe.

Trust is essential for collecting good data. Therefore, we should make efforts to increase the trust that respondents have.

The surveyor should also deliver value in exchange for participation in the survey.

Chapter 5 - Case research

5.1 Introduction

There are several challenges in conducting case research: it is time consuming, it needs skilled interviewers and care is needed in drawing generalizable conclusions from a limited set of cases and in ensuring rigorous research.

5.2 When to use case research

A case study is a unit of analysis in case research. It is possible to use different cases from the same firm to study different issues, or to research the same issue in a variety of contexts in the same or different firms. Strengths of case research:

1. The phenomenon can be studied in its natural setting and meaningful, relevant theory generated from the understanding gained through observing actual practice.
2. The case method allows the questions of why, what and how to be answered with relatively full understanding of the nature and complexity of the complete phenomenon.
3. The case method lends itself to early, exploratory investigations where the variables are still unknown and the phenomenon not all understood.

Case studies can be used for different types of research purposes, such as exploration, theory building, theory testing and theory elaboration/refinement. It is important to match the research purpose to the research questions, and in turn match the research structure to the research purpose and questions.

Exploration and theory building uses an inductive approach, theory testing requires a deductive approach and abductive approaches are suitable for examining theory elaboration and where empirical observations are incongruent with existing theory (Table 5.1 blz. 170).

5.3 The research framework, constructs and questions

The starting point for a case research can be theory or observation and from this the development of a research framework and questions. Such a framework explains, either graphically or in a narrative form, the main things that are to be studied (key factors, constructs, variables) and the presumed relationships among them. The next vital step in designing case research is the initial research question behind the proposed study. This may precede or follow directly from the conceptual framework.

5.4.1 What is the ideal number of cases?

Single cases have the advantage of greater depth but also limitations:

1. The limit of generalizability of the conclusions, models or theory developed.
2. Risk of misjudging a single event

Multiple cases and embedded cases have the advantage of augmenting external validity and help guard against observer bias, but more resources are needed, and less depth per case

(Table 5.3 - blz. 175).

5.4.2 Current or retrospective cases?

A second choice in case selection is whether to use retrospective or current cases. When researching **current case studies**, it is usually necessary to collect some archival and/or historical data. **Retrospective cases** allow for more controlled case selection.

5.4.3 Case selection and sampling

Sampling involves two actions. The first is setting boundaries that define what you can study and connect directly to the research questions. The second step is creating a sample frame to help uncover, confirm or qualify the basic processes or constructs that underpin the study.

In case studies, we often build a sample of cases by selecting cases according to different criteria. When building theory from case studies, case selection using replication logic rather than sampling logic should be used. Each case should be selected so that it either:

- Predicts similar results (literal replication)
- Produces contrary results, but for predictable reasons (theoretical replication)

Three kinds of instances have great payoff in case research:

1. If you can find a typical or representative case, can you find another one?
2. The negative or disconfirming instance
3. Exceptional or discrepant instance

When selecting cases it is also important to consider what are the parameters or factors that define the population and are to be held constant across the sample. Controls rely on the selection of the phenomena during the study's experimental design stage for their control. This allows particular factors to be 'held constant' while others are left free to vary as they would naturally.

5.5 Developing research instruments and protocols

Reliability and validity of case research data will be enhanced by a well-designed research protocol.

Reliability is the degree to which a measure is free from random error components.

Validity is the extent to which a measure only reflects the desired construct without contamination from other systematically varying constructs.

A protocol contains the research instruments, but also the procedures and the general rules that should be used when deploying the instrument and indicate who or from where different sets of information are to be sought. The core of the protocol is the set of questions to be used in interviews. A commonly used format is the funnel method. This starts with broad and open-ended questions first, and as the interview progresses, the questions become more specific and the detailed questions come last.

5.5.1 Single or multiple respondents and viewpoints

In research design, we must consider the trade-off between efficiency in data collection and richness of data. On the one hand, by posing the same question to a number of people, we may enhance the reliability of our data, and by going beyond formal interviews we can collect much valuable data. On the other hand, it can be very time consuming.

5.6.1 Who to contact

In researching case-based data, it is important to seek out the person(s) who are best informed about the phenomenon and context being researched.

5.6.3.1 Single or multiple investigators

Doing interviews in pairs increases the probability of a common approach being used in all sites and allows inter-rater reliability to be checked. **Inter-rater reliability** can be defined in terms of the degree to which raters agree or disagree on the rating or interpretation of the evidence presented to them.

5.6.3.5 Seeking convergence and clarification

In the field there are a number of things that a researcher should be paying attention to. The first is looking for convergence of views and information about events and processes. When finding differing views, it is important to challenge, to revisit the issue and to seek other sources of data to clarify the information.

5.7 Reliability and validity in case research

Construct validity is the extent to which we establish correct operational measures for the concepts being studied. If the construct as measured can be differentiated from other constructs, it also possesses discriminant validity. Construct validity can be tested by:

- Observing whether predictions made about relationships to other variables are confirmed
- Using multiple sources of evidence
- Seeing if a construct as measured can be differentiated from another
- Seeking triangulation that might strengthen construct validity.

Internal validity is the extent to which we can establish a causal relationship whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships.

External validity is knowing whether a study's finding can be generalized beyond the immediate case study.

Reliability is the extent to which a study's operations can be repeated, with the same results.

5.9 Analysis

There are two steps in analysis: analysis of within-case data, and searching for cross-case patterns.

5.9.1 Analysing data- within cases

The first step is to analyse the pattern of data within cases. Using displays, the overall idea is to become intimately familiar with each case as a stand-alone entity, and to allow the unique patterns of each case to emerge before you seek to

generalize across cases. This in turn gives the researcher the depth of understanding that is needed for cross-case analysis. Ways of analysing case data:

- Case dynamics matrix: displays a set of forces for change and traces the consequential processes and outcomes.
- Making predictions and then using the case data to test them.
- Causal network: a display of the most important independent and dependent variables in a field study and of the relationships among them.

5.9.2 Analysing data- searching for cross-case patterns

The systematic search for cross-case patterns is a key step in case research. The most effective method is to construct an array. Having constructed an array a simple analytical approach is to pick a group or category and to search within for group similarities or differences.

Approaches to facilitate cross-case analysis:

- Partially ordered displays.
- With well-coded and quantified case data, continuous measures or data ordered in sequences can be developed.

Chapter 9 - Modelling and simulation

9.2.1 Scientific management

The essence of scientific management was the analysis of instances of real-life operational processes, based on systematic observations and measurements of these process instances and the redesign of these processes in order to improve quality and productivity.

9.2.2. Business schools and idealized problems: operations research

An idealized model is a model where, in addition, the abstraction from reality has been further extended so that essential trade-offs become very explicit, functions become one- or two-dimensional, differentiable, etc., in order to make the model tractable for mathematical analysis.

An important shortcoming of the idealized problems is therefore that the effect of the human factor on the performance of the operational process is largely neglected. As a result, implementing problem solutions based on these models turned out to be a tedious process, and frequently failed.

An operations research methodology has been developed mainly dealing with technique-oriented modelling of problem instances and implementing of solutions derived from the model.

9.2.4 Influential work from quantitative modelling

With scientific models, we mean models which can be used to predict the behaviour or performance of operational processes, and which can be validated empirically in an objective way. The operations research literature contains valuable knowledge about aspects of operational processes, and operational research contains valuable knowledge about problem instances.

Apart from the impact of work in forecasting, inventory modelling and mathematical optimization, three other streams of work have had significant impact in real life. These three exceptions are industrial (system) dynamics, queueing theory and the research on the learning curve.

9.2.6 Implications for current modelling research in OM

The clear impact of both operations research and operational research can still be observed. Much of the model-based research has a strong focus on model-based analysis and managerial insight of simplified models and solution methodologies for complex but single-aspect formalized models.

9.3. Methodologies in quantitative modelling

9.3.1 Method and methodology

Quantitative model-based research can be classified as a rational knowledge generation approach. It is based on the assumption that we can build objective models that explain (part of) the behaviour of real-life operational processes or that can capture (part of) the decision making problems that are faced by managers in real-life operational processes.

In survey research the relationships are also defined between variables. However, generally in survey research the range over which the variables vary is not always defined explicitly and the relationship between the variables is usually not causal, and in most cases not quantitative. With quantitative in this observation, we mean that the extent to which the dependent variable changes when a specified change in the independent variable occurs, is quantitative.

An important consequence of the fact that relationships are causal and quantitative is that the models can be used to predict the future state of the modelled processes rather than be restricted to explaining the observations made.

Consequently, we can distinguish two distinct classes of model-based OM research: axiomatic quantitative modelling research and empirical quantitative modelling research.

9.3.2 Axiomatic research

In **axiomatic research**, the primary concern of the researcher is to obtain solutions within the defined model and make sure that these solutions provide insights into the structure of the problem as defined within the model. Axiomatic research produces knowledge about the behaviour of certain variables in the model, based on assumptions about the behaviour of other variables in the model.

The types of models that are studied in this research line are largely determined by the available methods and techniques in mathematics, statistics, and computer science.

- **Prescriptive research** is primarily interested in developing policies, strategies and actions to improve over the results available in the existing literature, to find an optimal solution for a newly defined problem or to compare various strategies for addressing a specific problem.
- **Descriptive research** is primarily interested in analysing a model, which leads to understanding and explanation of the characteristics of the model.

9.3.3 Empirical research

In **empirical research**, the primary concern of the researcher is to ensure that there is a model fit between observations and actions in reality and the model made of that reality.

- **Descriptive empirical research** is primarily interested in creating a model that adequately describes the causal relationships that may exist in reality, which leads to understanding of the process going on.
- **Prescriptive empirical quantitative research** is primarily interested in developing policies, strategies and actions to improve the current situation.

In contrast with axiomatic quantitative research, empirical quantitative model-based research has not been very productive.

9.3.4 General differences between axiomatic and empirical research

Number of phases in operational research approach (figure 9.1 blz. 302).

- **Conceptualization:** the researcher makes a conceptual model of the problem and system he is studying.
- **Modelling:** the researcher actually builds the quantitative model, thus defining causal relationships between the variables.
- **Model solving:** mathematics play an important role
- **Implementation:** the results of the model are implemented, after which a new cycle starts

In axiomatic descriptive research, the modelling process is central. The researcher typically does not move into the model-solving phase. This extension is made in axiomatic prescriptive research, where the model-solving process is the central research process reported.

In empirical descriptive research, the researcher typically follows a cycle: conceptualization - modelling- validation. Empirical prescriptive has a cycle of: conceptualization- modelling - model solving - implementation.

9.4 How to conduct quantitative research in operations management

9.4.2 Axiomatic descriptive research - analytical and numerical

We distinguish two types of analytical research in OM. The first type of research (axiomatic descriptive) aims at creating managerial insights into the behaviour of operational processes and their control. The second type of research (axiomatic prescriptive) aims at developing rules and tools for managerial decision making.

9.4.2.1 Conceptual modelling

Axiomatic quantitative OM research starts with a condensed description of the characteristics of the operational process or the operational decision problem that is going to be studied. The conceptual model descriptions should use as much as possible concepts and terms that are accepted as standards published in scientific OM literature on the subject under study. It is also necessary to describe all assumptions that underlie the conceptual model.

We can distinguish two types of contribution:

- The study of a new variant of the process or problem, using well-known solution techniques.
- To study a process or problem that has been studied before, but provides a new, or better, solution to the problem, either by applying new types of

solution techniques to the problem, or by achieving better results with accepted solution techniques.

9.4.2.2 Scientific modelling

The second phase in axiomatic quantitative research is the specification of the scientific model of the process or problem. The scientific model must be presented in formal, mathematical terms such that either mathematical or numerical analysis is possible, or computer simulation can be carried out. In addition, the relationships in the model should be explained, and possibly related to earlier work in which similar relations have been developed.

Validity can be claimed in three ways:

1. The researcher may refer to scientifically accepted axiomatic descriptions of the system studied that contain evidence of the occurrence of the characteristics in real life.
2. The researcher may refer to published empirical research that shows the existence in real life of the characteristics captured in the model.
3. The researcher may simply refer to earlier published research that uses the same modelling assumptions.

There are two reasons for using small-scale models:

1. Problems may exist where results obtained from a small scale can be scaled up to larger models.
2. High dimensional models may be analytically intractable; therefore, results can only be obtained for small-scale models.

9.4.2.3 Analysis, solution and proofs

Researchers analyse the scientific model using algebraic techniques, numerical techniques or computer simulation. The objective of using algebraic techniques is to develop so-called 'closed-form solutions', which are expressions in which all variables can be related and only simple mathematical function can be included. If this is not possible, computer simulation is used.

Good research is not just the result of analytical skills or applying a methodology, but also the result of good intuition in combination with analytical skills and a good methodology.

9.4.2.4 Insights

After providing the analysis and developing the solution, the researcher needs to deduce managerial insights from the analysis, solution and proofs. This requires

the researcher to relate the scientific model to the conceptual model and develop insights within the conceptual model assumptions.

9.4.3 Axiomatic prescriptive research - decision rules

Decision rule oriented research is more ambitious than managerial insight oriented research. Its goal is to provide the manager with decision rules that, when applied, achieve optimal or near optimal performance with respect to some criterion function.

9.4.5 Axiomatic research - simulation

Simulation is used where the model or problem is too complex for formal mathematical analysis. This type of research generally leads to lower scientific quality results than research using mathematical analysis, but the scientific relevance of the process or problem studied may be much higher. There is a trade-off between scientific relevance of the process/problem and scientific quality of the results.

9.4.5.1 Conceptual modelling

The initial conceptual model is typically far richer and the objective may not be limited to obtaining insights but more extensive results may be developed.

9.4.5.2 Justification of the research method

A very important step in simulation research is the justification of this research method.

9.4.5.3 Justification of the heuristics or hypothesis

The second step is the justification of the solution or hypothesis to be tested. In simulation research, no proof is possible, so we need to be very careful in selecting our heuristic solution or hypothesis.

9.4.5.4 Development of the scientific model

The simulation model should only be developed after the hypotheses have been developed. The hypotheses drive the scientific model development in a number of ways.

- It defines what to include and what not to include in the model.
- The hypotheses define what needs to be measured (recorded) during the simulation such that the right output can be generated.

9.4.5.5 Experimental design

The set-up of the experimental design must be done very carefully and in accordance with accepted standards. All factors in the scientific model that may have an impact on the quality of the solution or results must be identified and have to be varied in the simulation over a sufficiently large range of values with sufficient detail.

9.4.5.6 Analysis of results

The sixth step concerns the statistical analysis of the results of the computer simulations.

9.4.5.7 Interpretation of results

The last step concerns the interpretation of the results of the analysis related to the research question in the conceptual model. In this step, the results are considered in the context of the conceptual problem description and the researchers derive conclusions about the extent to which the original questions are answered and what new questions emerge from these results.

9.4.7 Model-based empirical research

Quantitative model-based empirical research is concerned with either testing the (construct) validity of the scientific models used in quantitative theoretical research, or with testing the usability and performance of the problem solutions obtained from quantitative theoretical research, in real-life operational processes.

Empirical research should aim at validating the basic assumptions about the operational processes and problem characteristics for well-defined classes of operational processes, underlying the theoretical models and problems. From these observations we can derive the steps that need to be taken when doing empirical quantitative research.

9.4.7.1 Identification of process or problem assumptions

The first step is the identification of the basic assumptions regarding the operational process underlying the theoretical models or problems.

9.4.7.2 Identification of process and problem types

The second step is that researchers should identify the type of operational process and the type of decision problem regarding this operational process to which the basic assumptions are assumed to apply.

9.4.7.3 Development of operational definitions of the process

The third step is that operational, objective criteria must be developed for deciding whether or not a real-life operational process belongs to the class of operational processes considered and for identifying the decision system in the operational process that represents the decision problem considered.

9.4.7.4 Hypotheses development

The fourth step is to derive, from the basic assumptions, hypotheses regarding the behaviour of the operational process. This behaviour refers to variables or phenomena that can be measured or observed at the operational process in an objective way. The more different testable hypotheses derived from basic assumptions are, the stronger the research is.

9.4.7.5 Measurement development

The fifth step is to develop an objective way to do measurement or to make the observations. This very crucial step requires documentation. Model-based empirical research cannot be done without a systematic approach for identifying and measuring real-life operational processes (conceptual modelling).

9.4.7.6 Data collection

The sixth step consists of applying the measurement and observation systems, collecting and documenting the resulting data.

9.4.7.7 Data analysis

The seventh step is the processing of the data, which generally will include the use of statistical analysis.

9.4.7.8 Interpretation of results

Finally, the last step in quantitative empirical research consists of the interpretation of the research results related to the theoretical models or problems that gave rise to the hypotheses that were tested. This step completes the validation process and may result in confirmation of (parts of) the theoretical model in relation to the decision problem and in relation to the operational process considered, but may also lead to (partial) rejections and suggestions for improving the theoretical models.